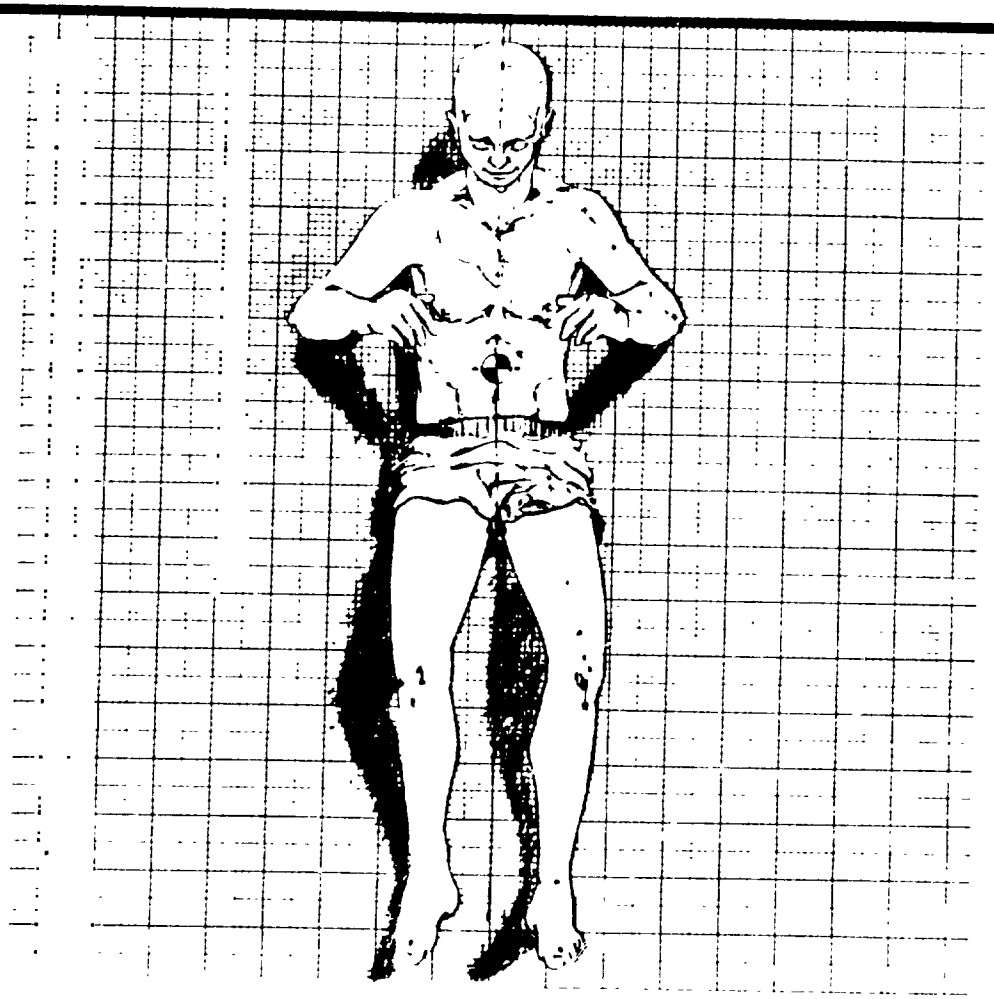
Considerations for Space Station Interior Architecture

Brand Griffin

Space Station

NASA
SS-1121

Neutral Body Postures



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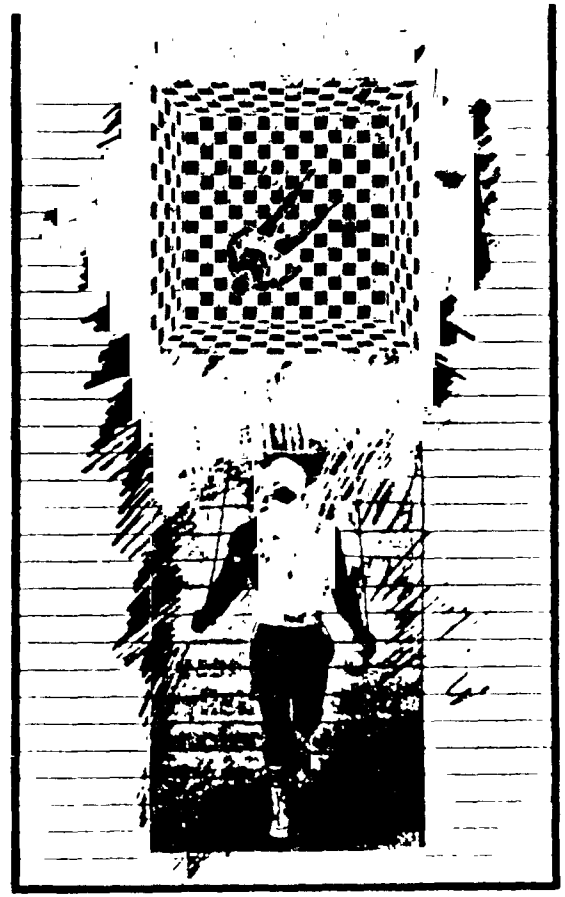
SS-1124

Contrasting Environments



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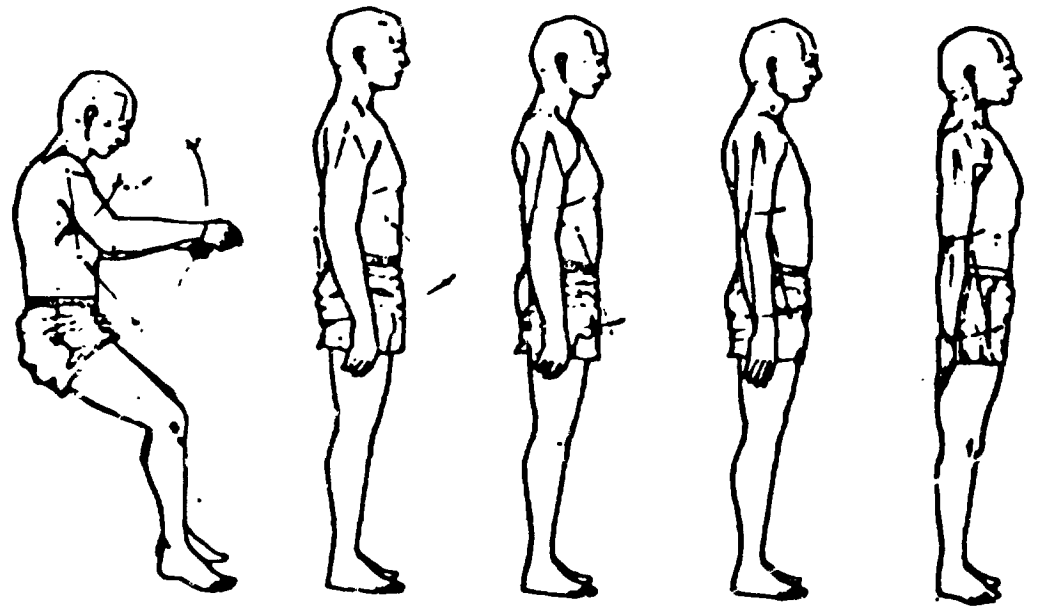
Acceleration Gradient

SS-1112

Variable:

Anthropometric Envelope (Nominal)

Acceleration



Zero-G | Partial-G | One-G | One-Two-G's | Over Two G's

Implications:

1. Location of controls.
2. Intravehicular and extravehicular garment fit.
3. Angular speed of limbs.

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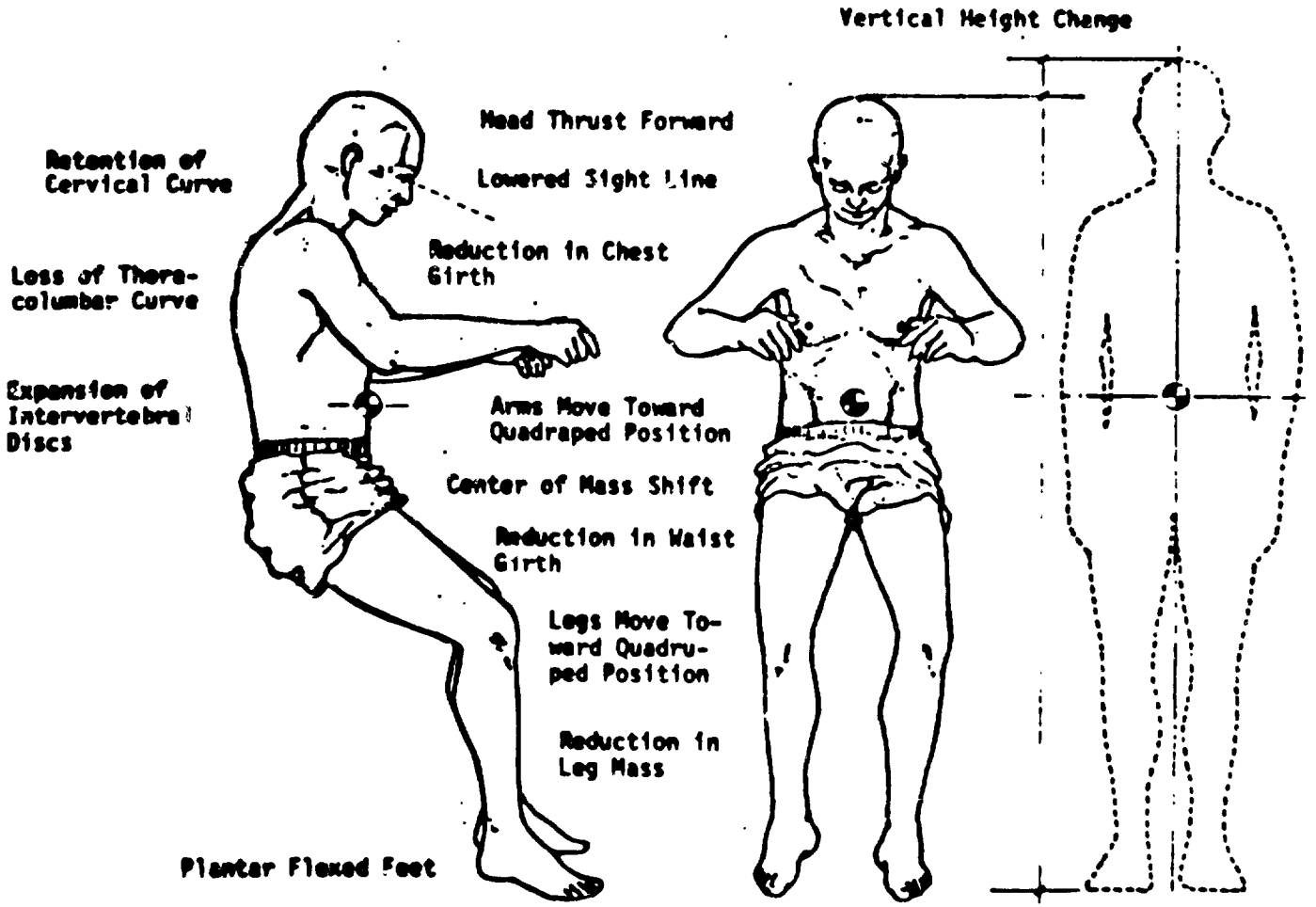
Anatomical Change in Zero-G



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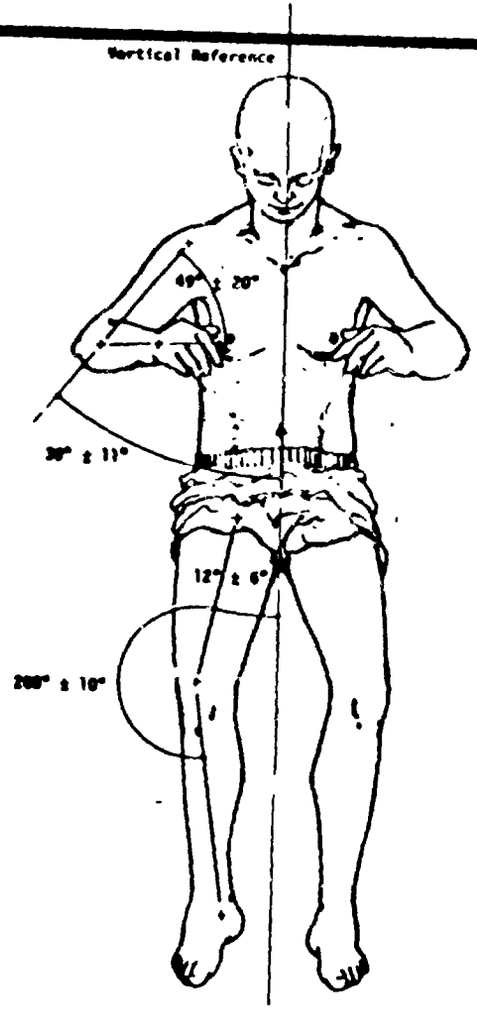
Male Angular Relationships

Ventril View



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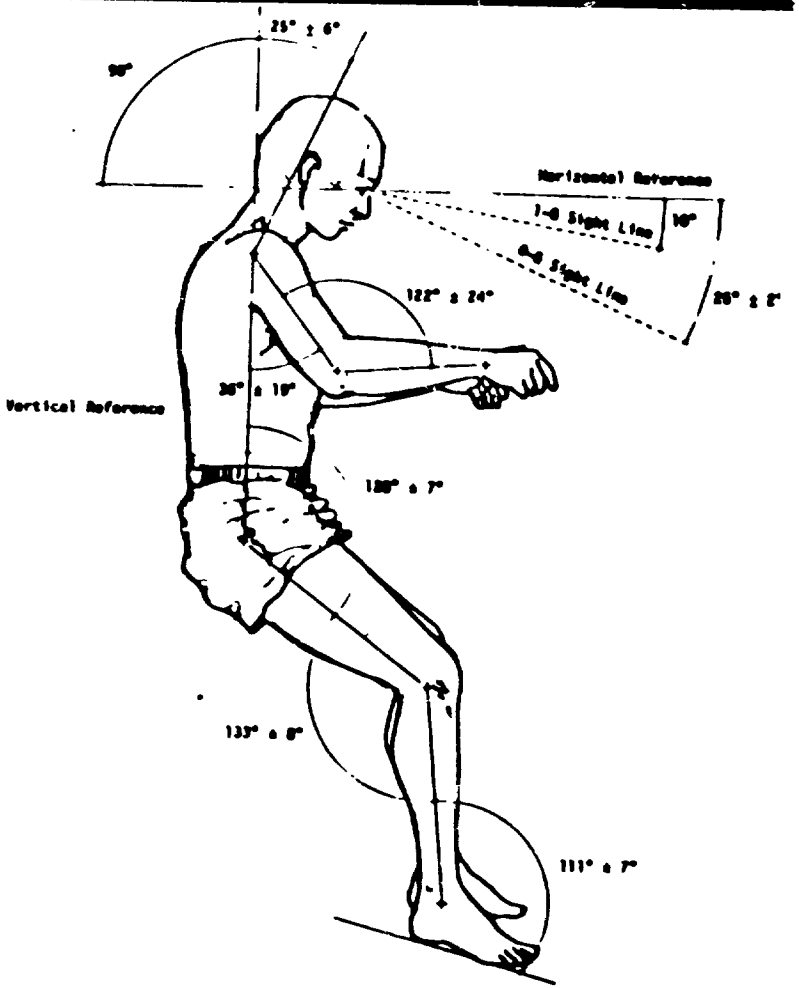
Male Angular Relationships

Profile View



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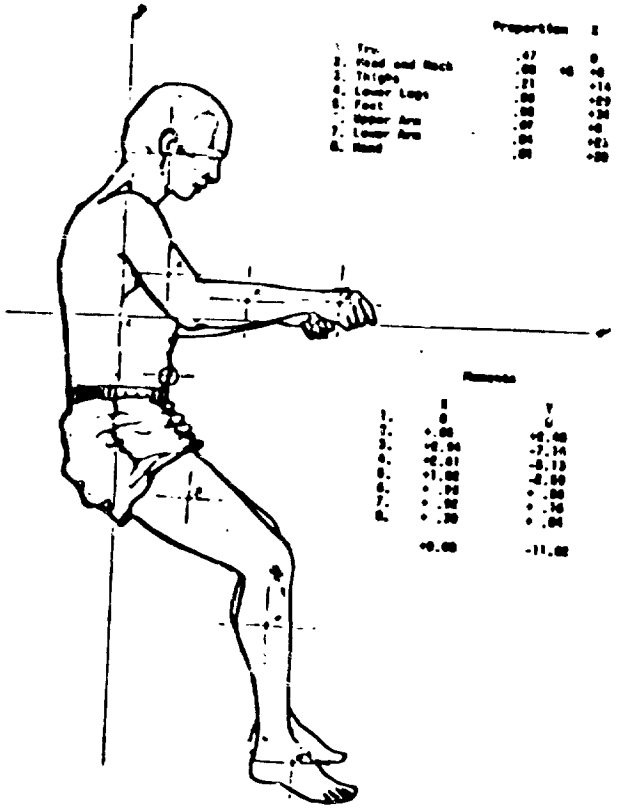
Center of Mass (Segmental Method)



NOTE: Proportional to fluid shift and duration of exposure to zero-g, the c.g. will move in the +y direction.

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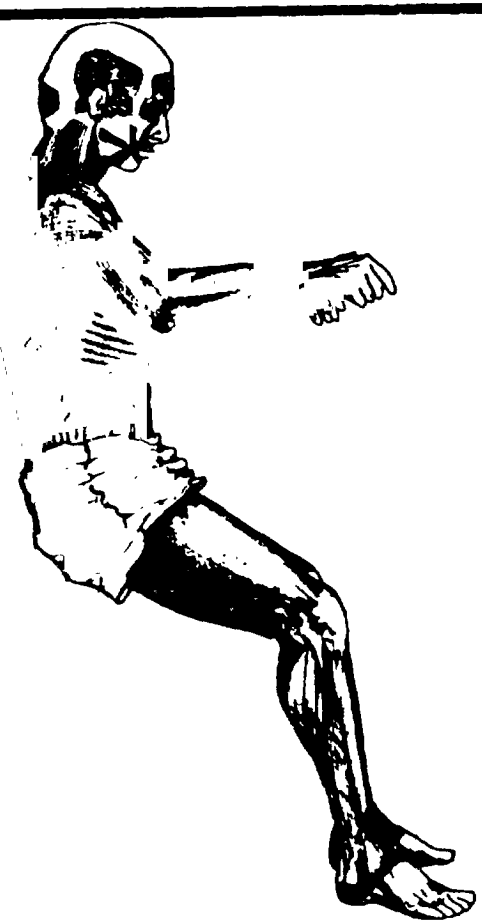
SS-1123

Neutral Body Posture
Muscular Considerations

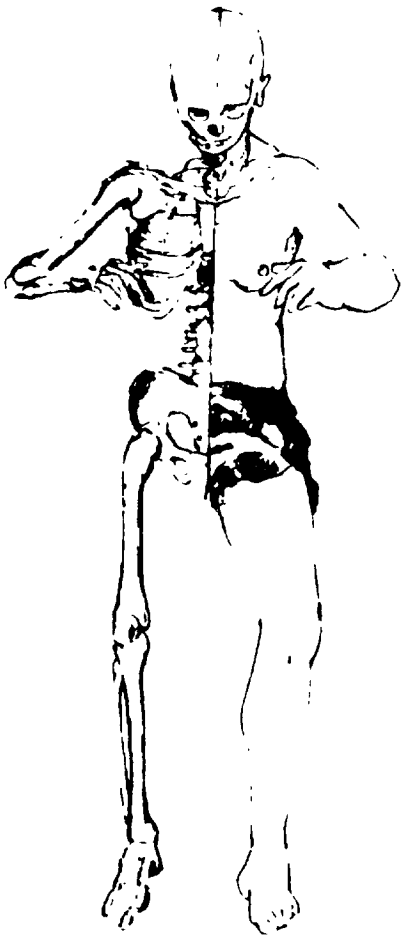


4-116

Space Station

NASA
SC-1122

Neutral Body Posture/Skele[illegible]



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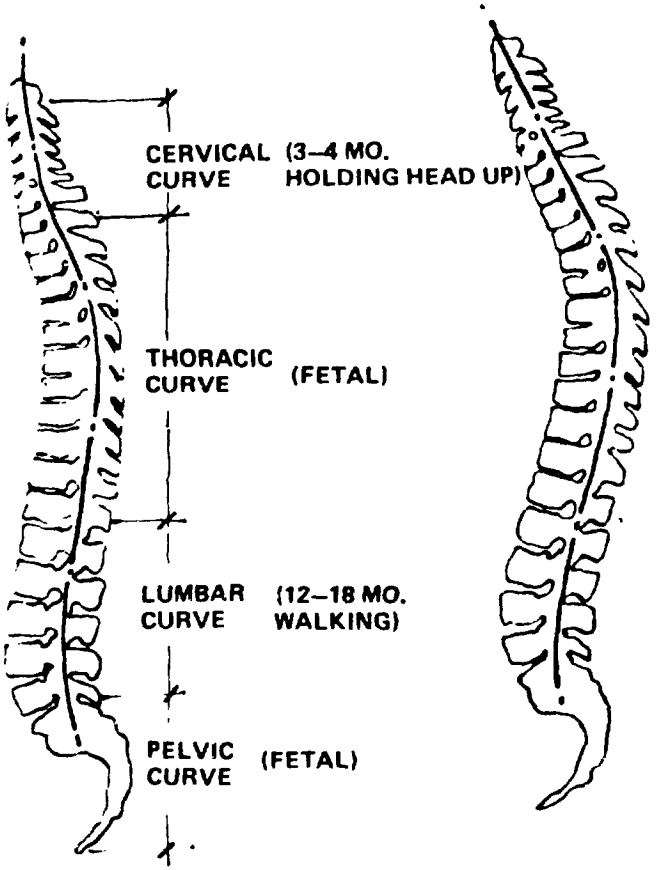
SS-1133

Zero-G Change to the Vertebrae Column



Space Station

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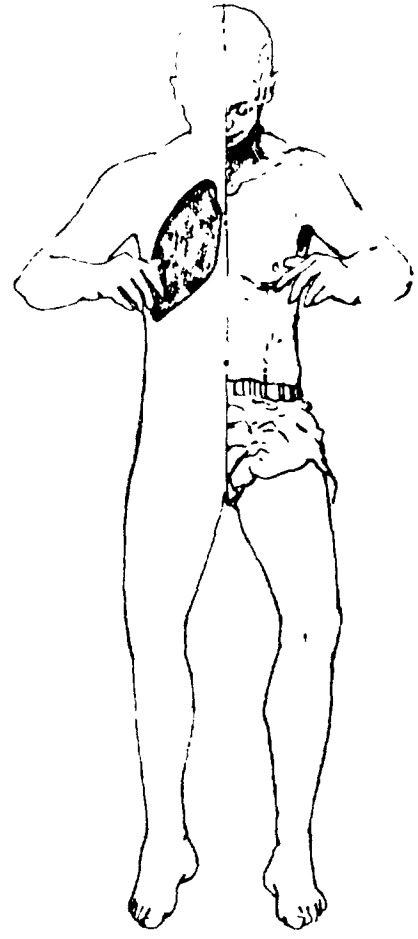
SS-1127

Neutral Body Posture/Pulmonary



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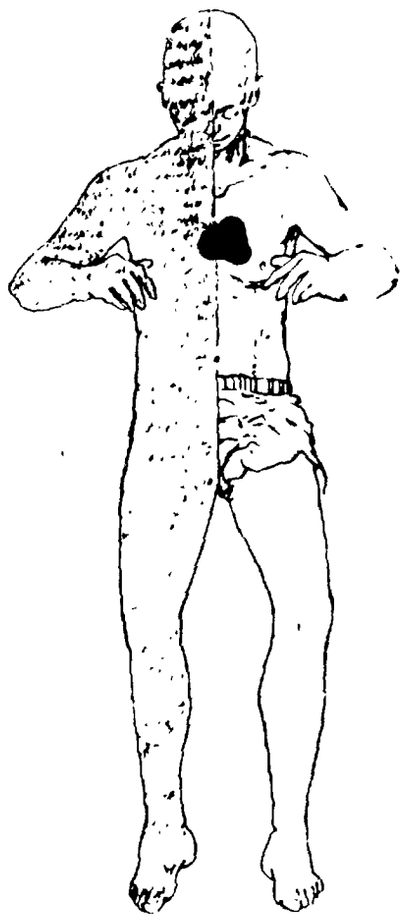
SS-1130

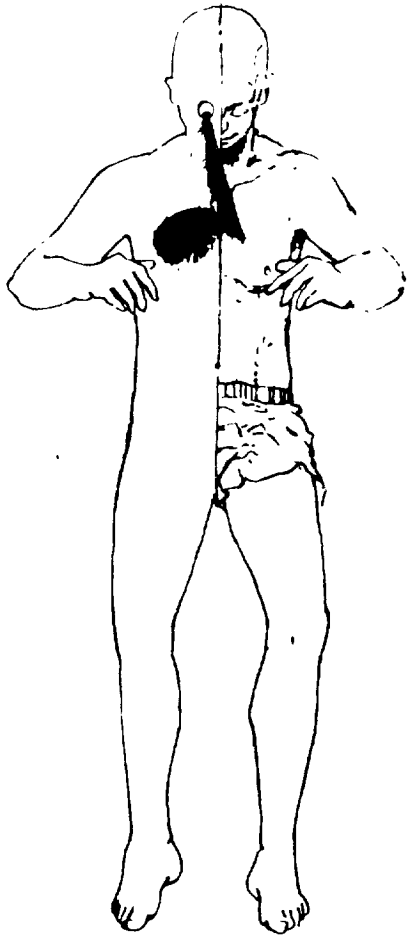
Neutral Body Posture/Cardiovascular



Space Station

NASA
SS-1125

Neutral Body Posture/Vision



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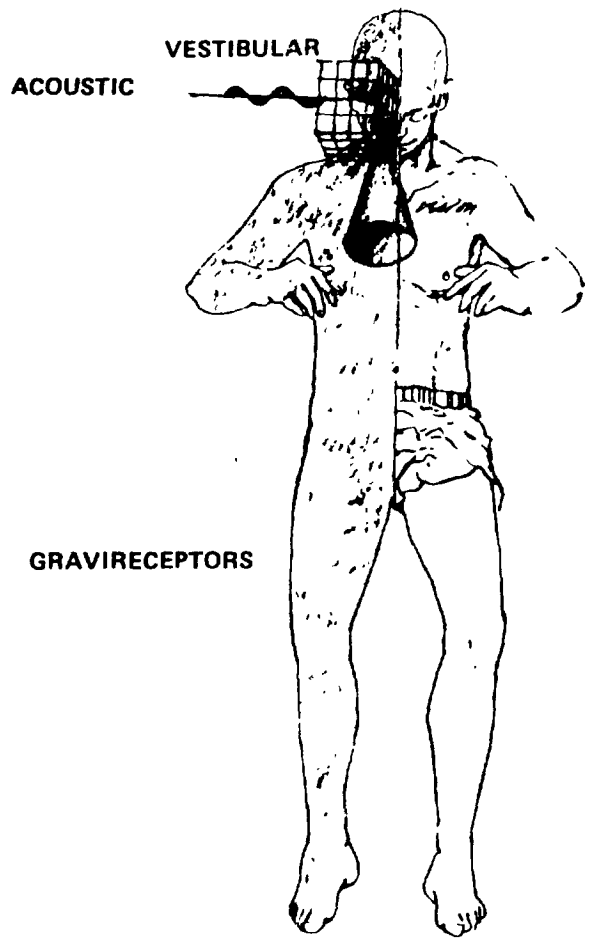
SS-1131

Neutral Body Posture/Orientation



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Neutral Body Posture and EVA Suit Fit

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Space Station

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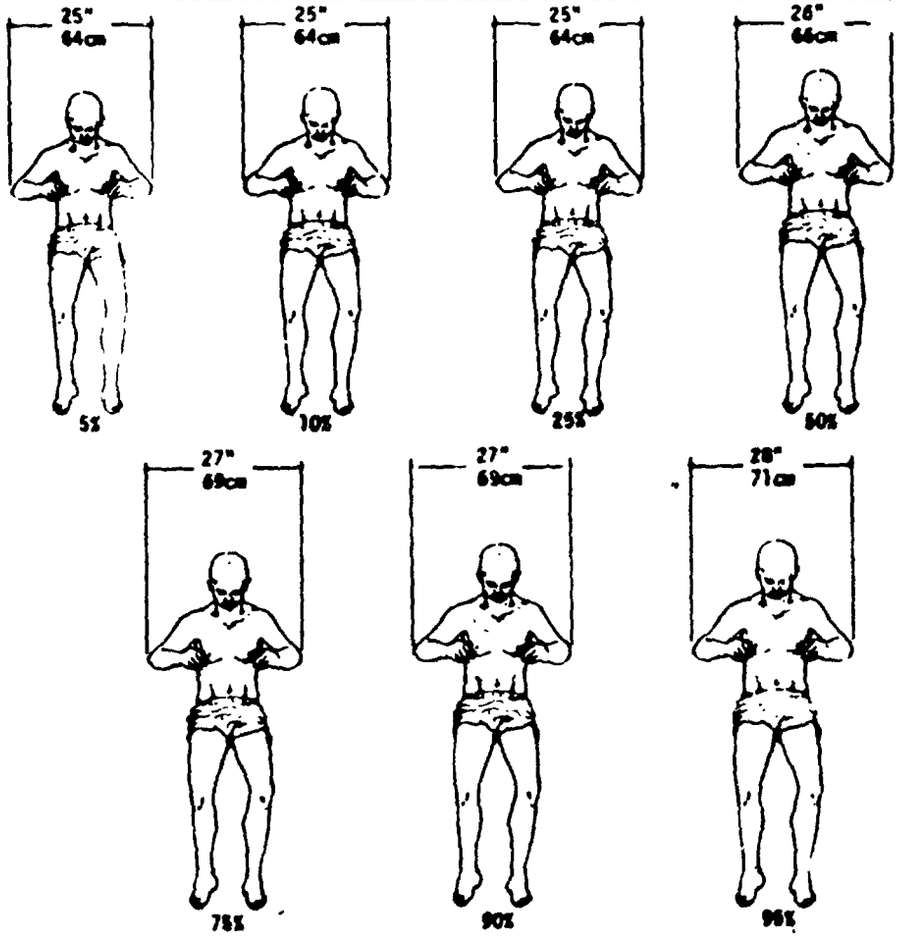
SS-1116

Norminal Dimensions of Male Neutral Body Posture Envelope by Percentile Groups Ventral Views



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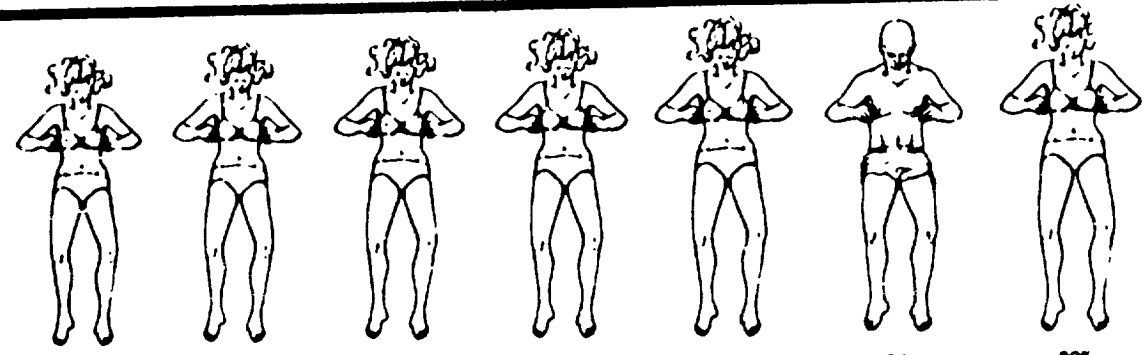
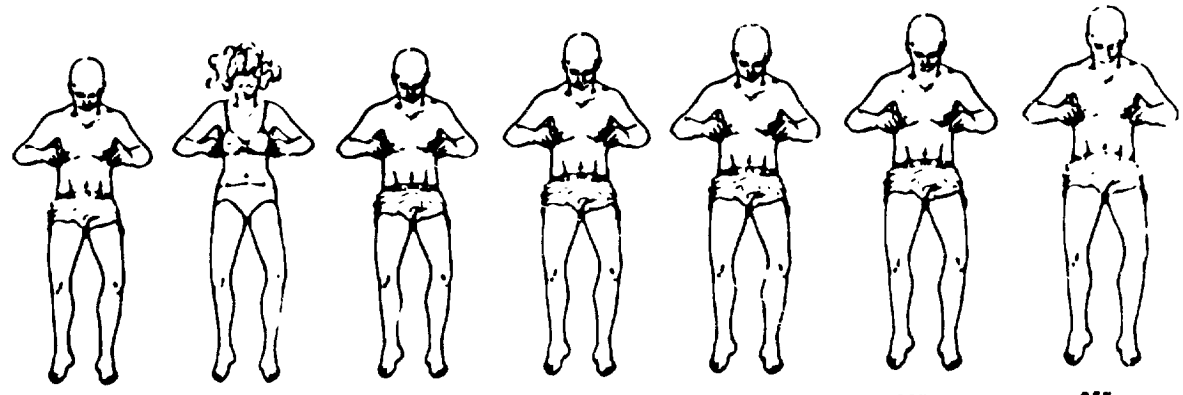
Male and Female N.B.P. Arranged by Height from Projected Astronaut Populations



PERCENTILE	5%	10%	25%	50%	75%	95%	90%
N.B.P *	54	54	56	58	59	60	61
1-G *	60.0	60.8	62.5	64.1	65.8	66.2	67.2

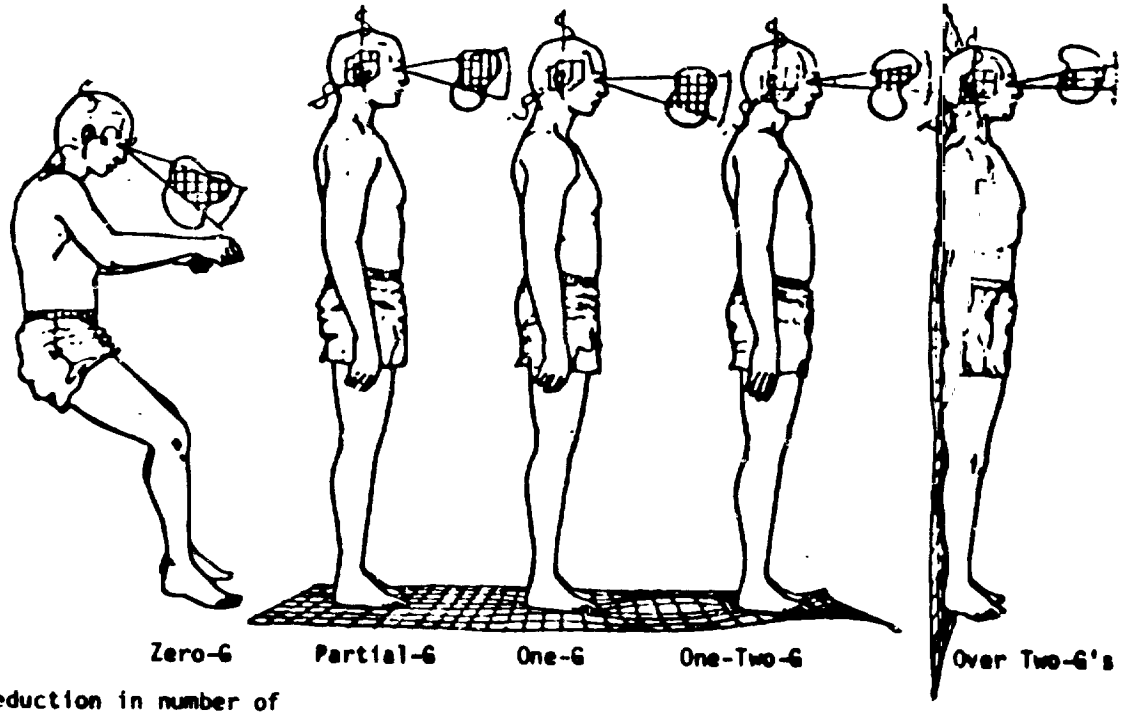


PERCENTILE	10%	95%	25%	50%	75%	90%	95%
N.B.P	61	61	62	63	64	66	67
1-G	67.3	68	68.5	70.2	71.6	73.0	74.3

Space Station

Comparitive Orientation Analyzers

NASA



Reduction in number of afferent impulses used for orientation.

1. No otolith functions.
2. No cutaneous (proprioceptive--must be imposed).

Tunnel Vision reduces field of sight.

Space Station

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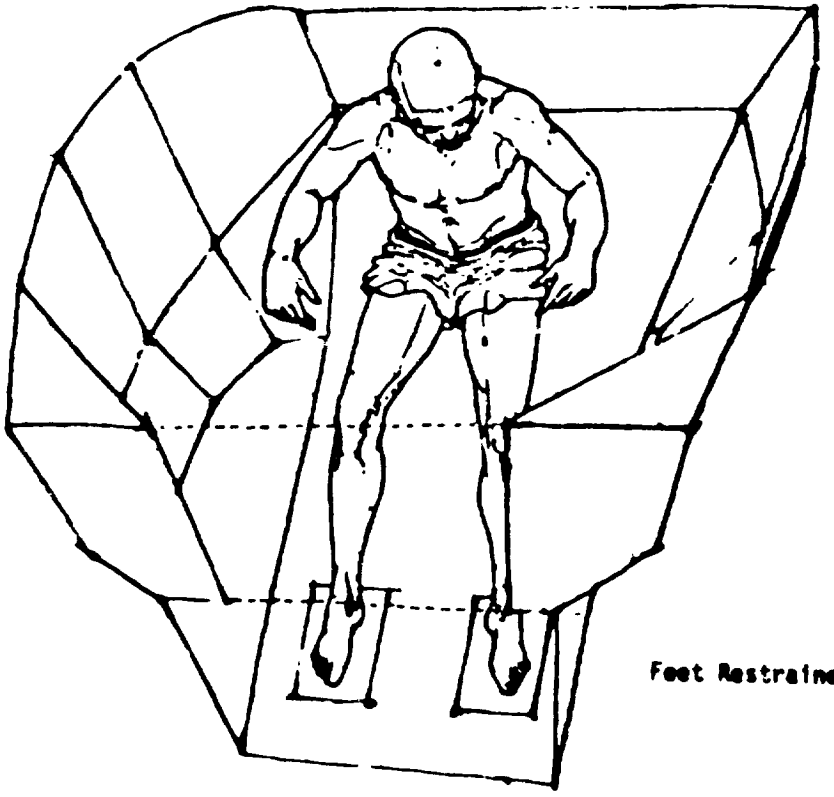
Work Station Diagram for the Dynamic Zero-G Envelope



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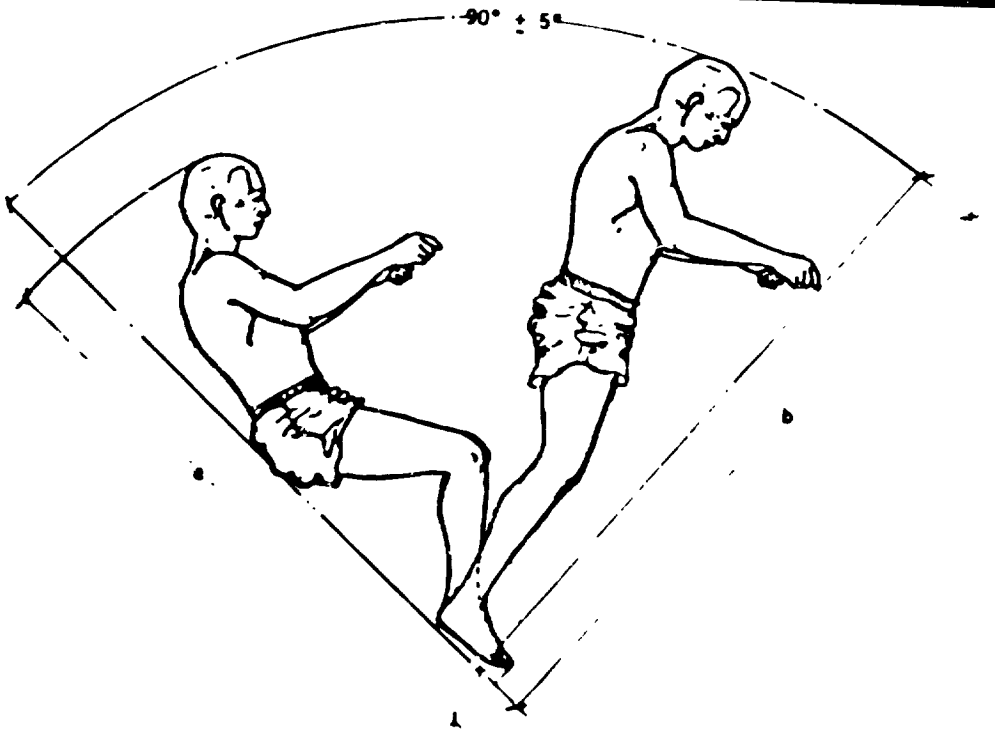
Dynamic Zero-G Envelope



NOMINAL LIMITS OF MOVEMENT FROM RESTRAINED FOOT POSITION

	MALE							FEMALE						
	5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
a°	58	59	60	62	75	64	65	53	53	55	57	58	59	61
b°	65	66	67	69	70	71	72	59	59	61	63	64	66	67

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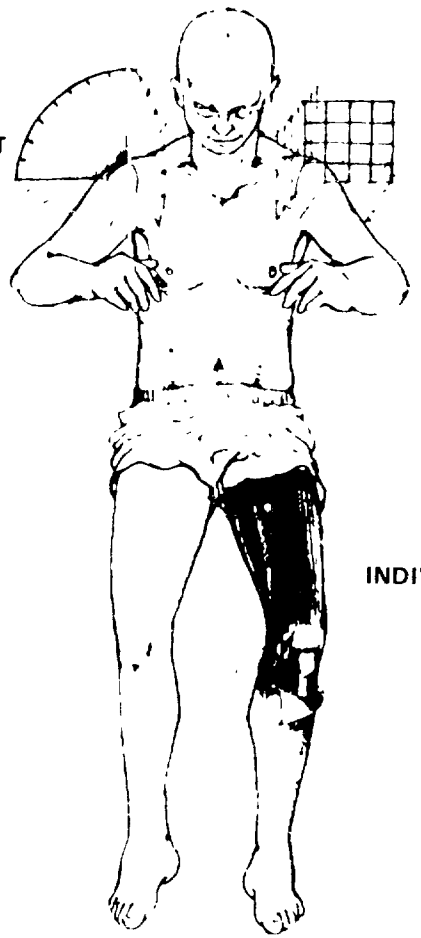
SS-1132

Quantifying Work from Neutral Body Datum



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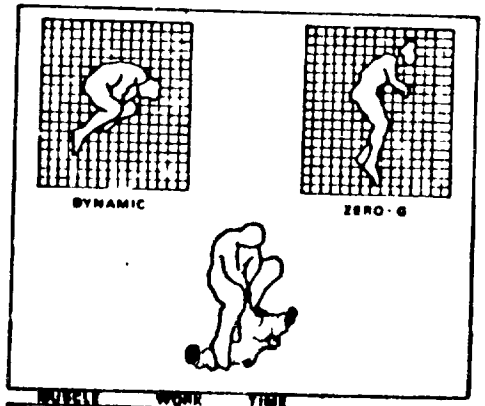
Zero-G Activity Analysis

(Donning and Doffing IVA Wear)

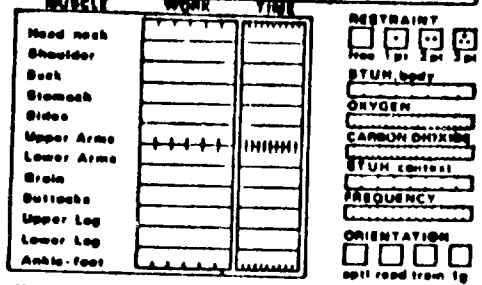
Work diagram - graphic portrayal of individual muscle work superimposed on N.B.P.

Profile, unit extreme posture exhibited for that activity



Nominal view - typ representative of activity

Body description by major muscle groups



Work exerted by muscle groups for that activity - calibration based on measurement through cybex isokinetic dynamometer, infared photography, EMG or photogrametry

Time each muscle group is working

Desired restraint necessary for efficient performance.

Heat produced by activity

Quantity of O_2 consumed

Quantity of CO_2 produced

Heat produced by equipment and other crewmembers within the immediate vacinity

No. of times the activity is performed in 24 hour period

Orientation required for that activity

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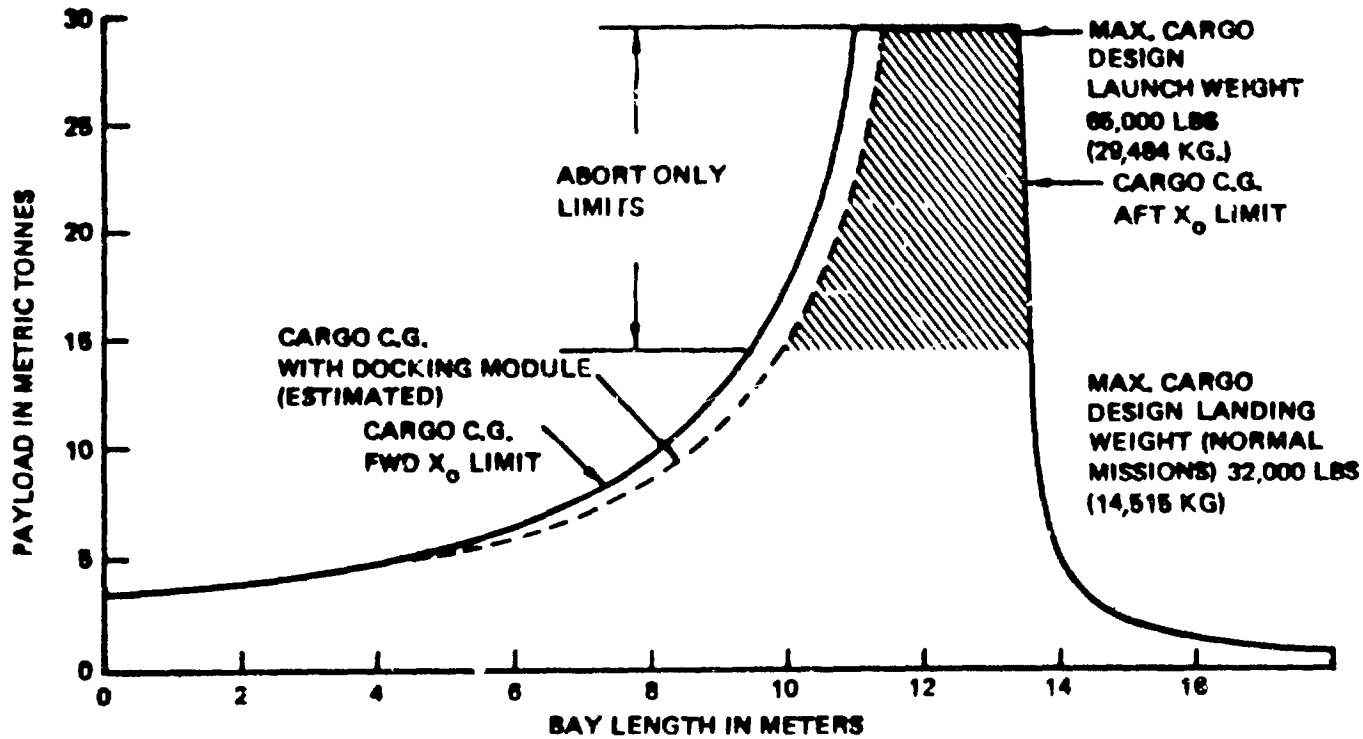
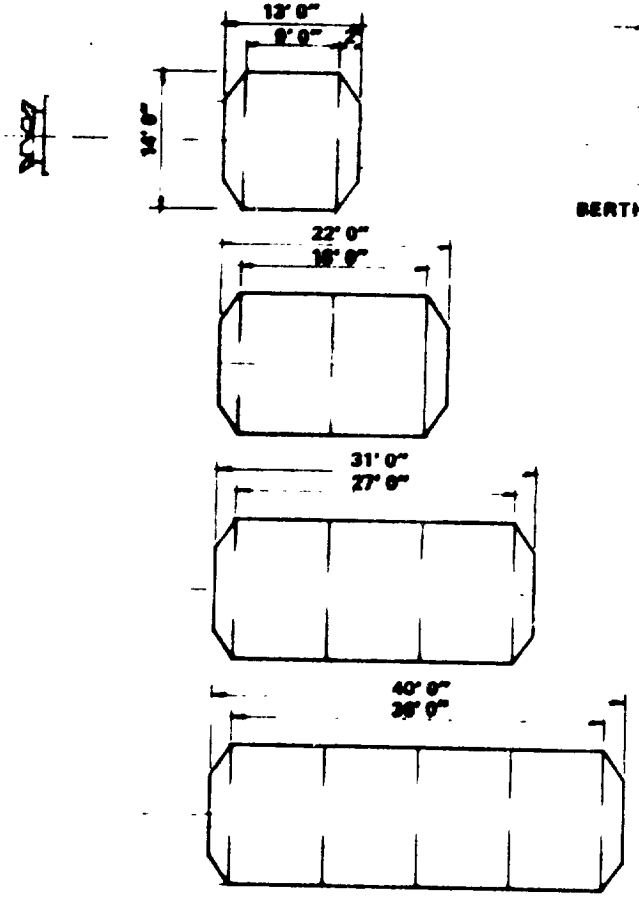
Shuttle Center of Gravity

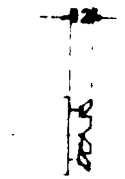


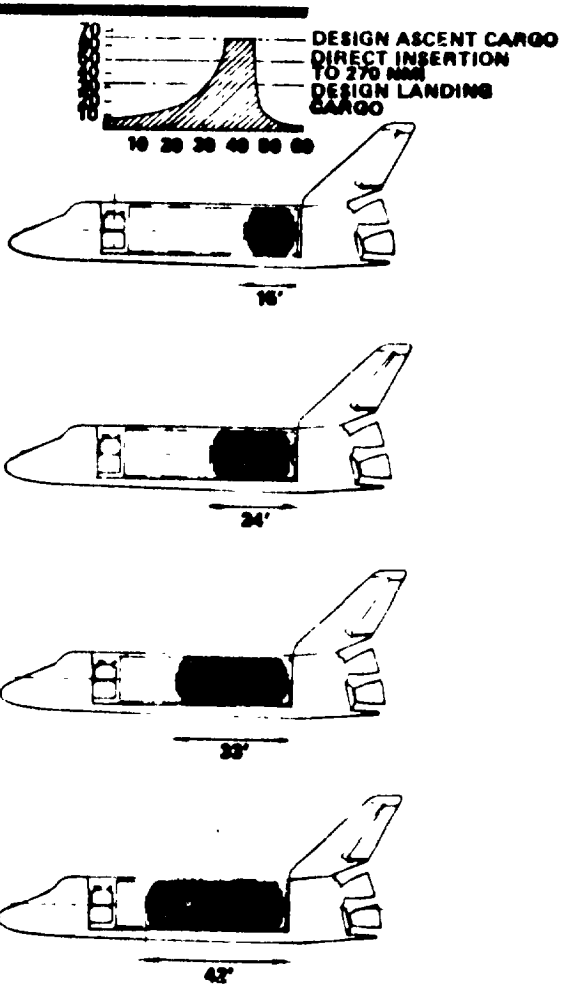
Space Station

Module Length

NASA

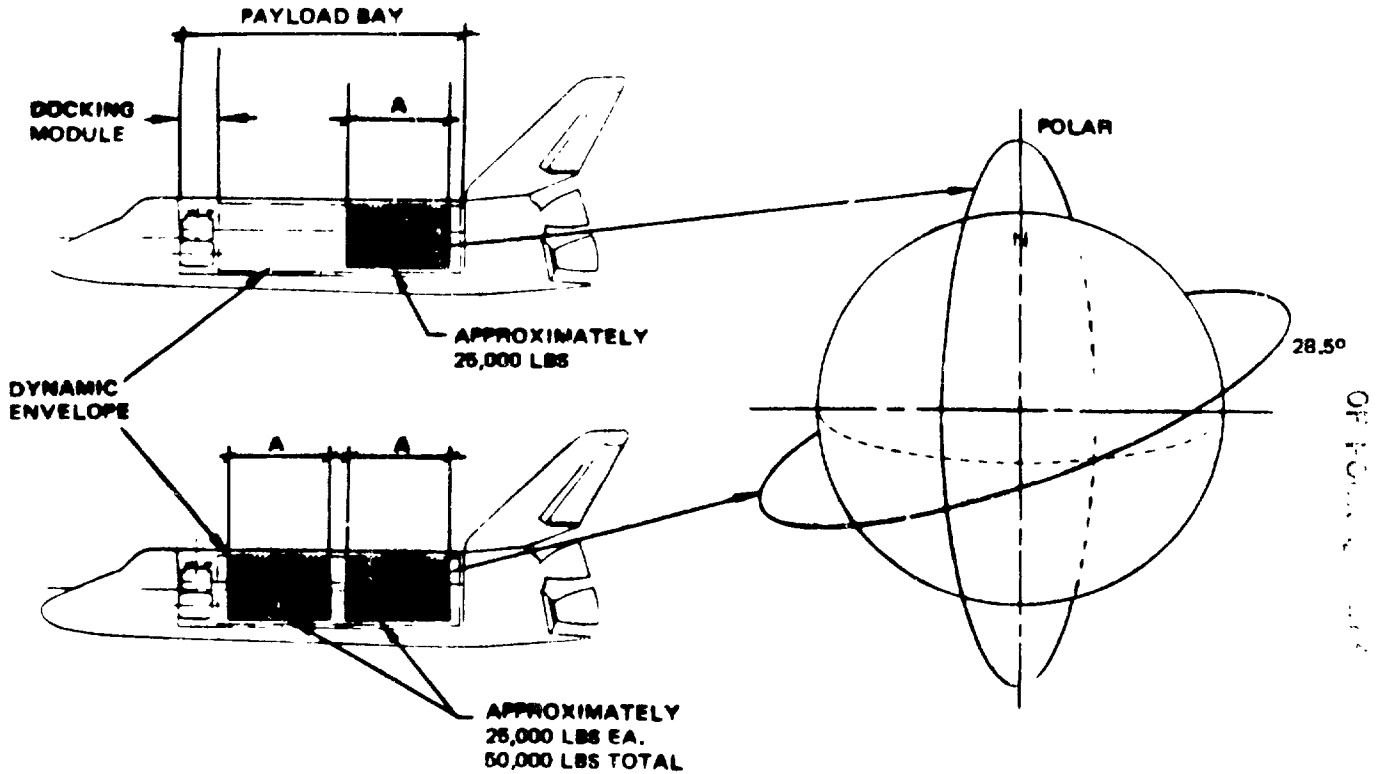






Space Station

Module Sizing Rationale
Incremental Architecture



SPACE
OPERATIONS
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SOC-1464

BOEING PROPRIETARY

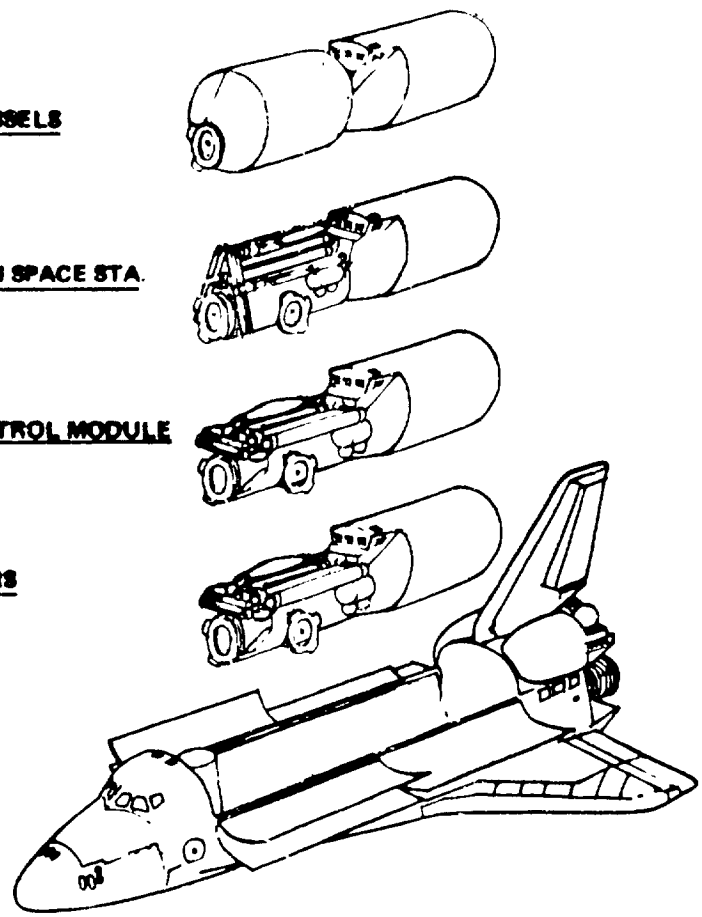
Delivery Options

TWIN PRESS VESSELS

SINGLE LAUNCH SPACE STA.

COMMAND/CONTROL MODULE

CREW QUARTERS



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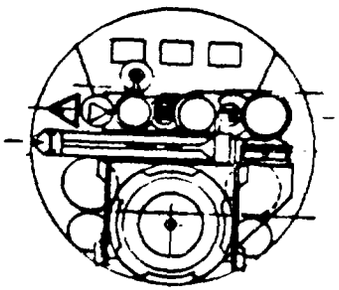
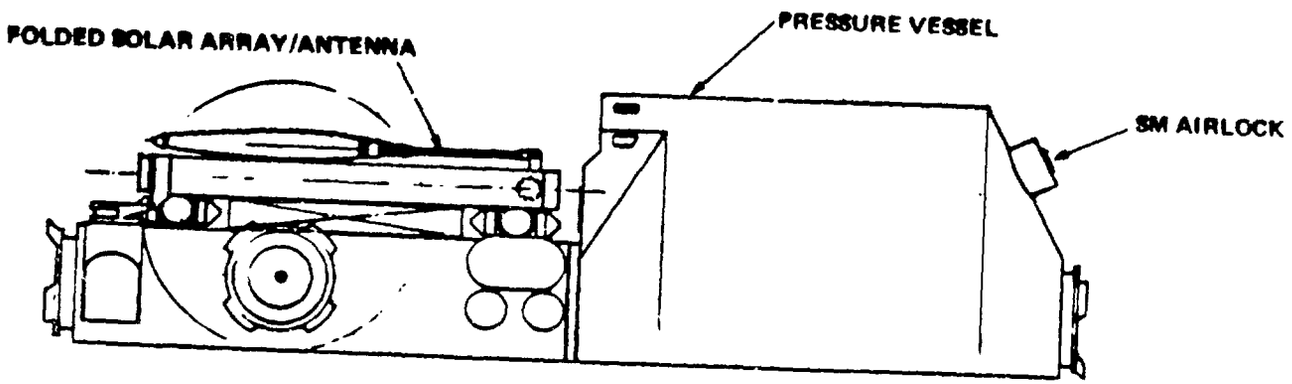
External View Alternative Module





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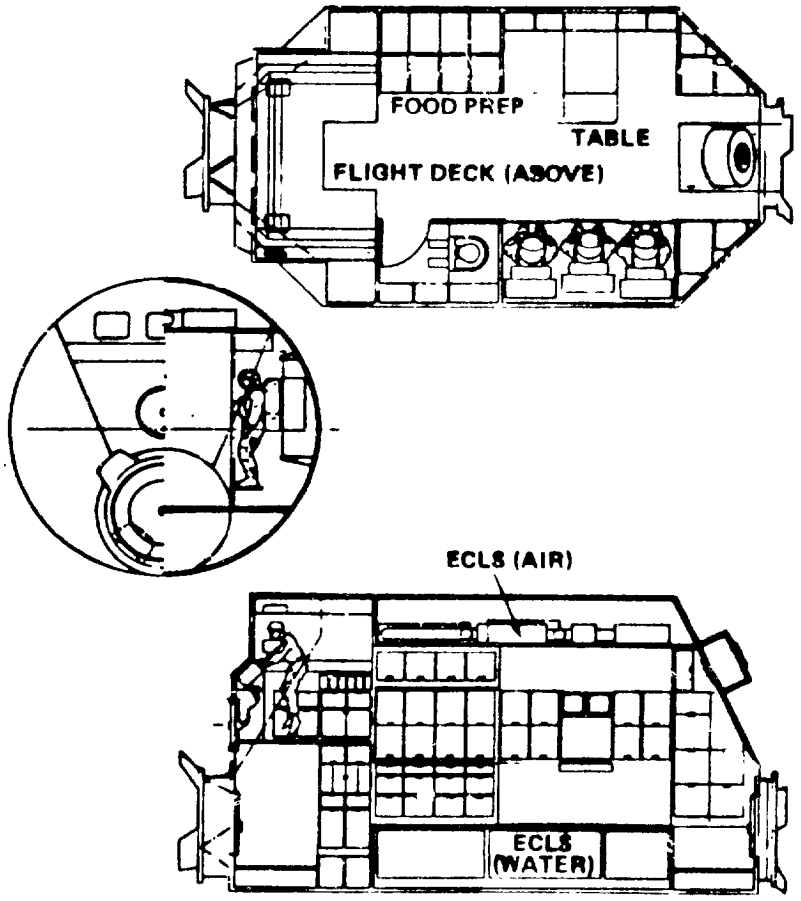
SOC-1467

Command/Control Module



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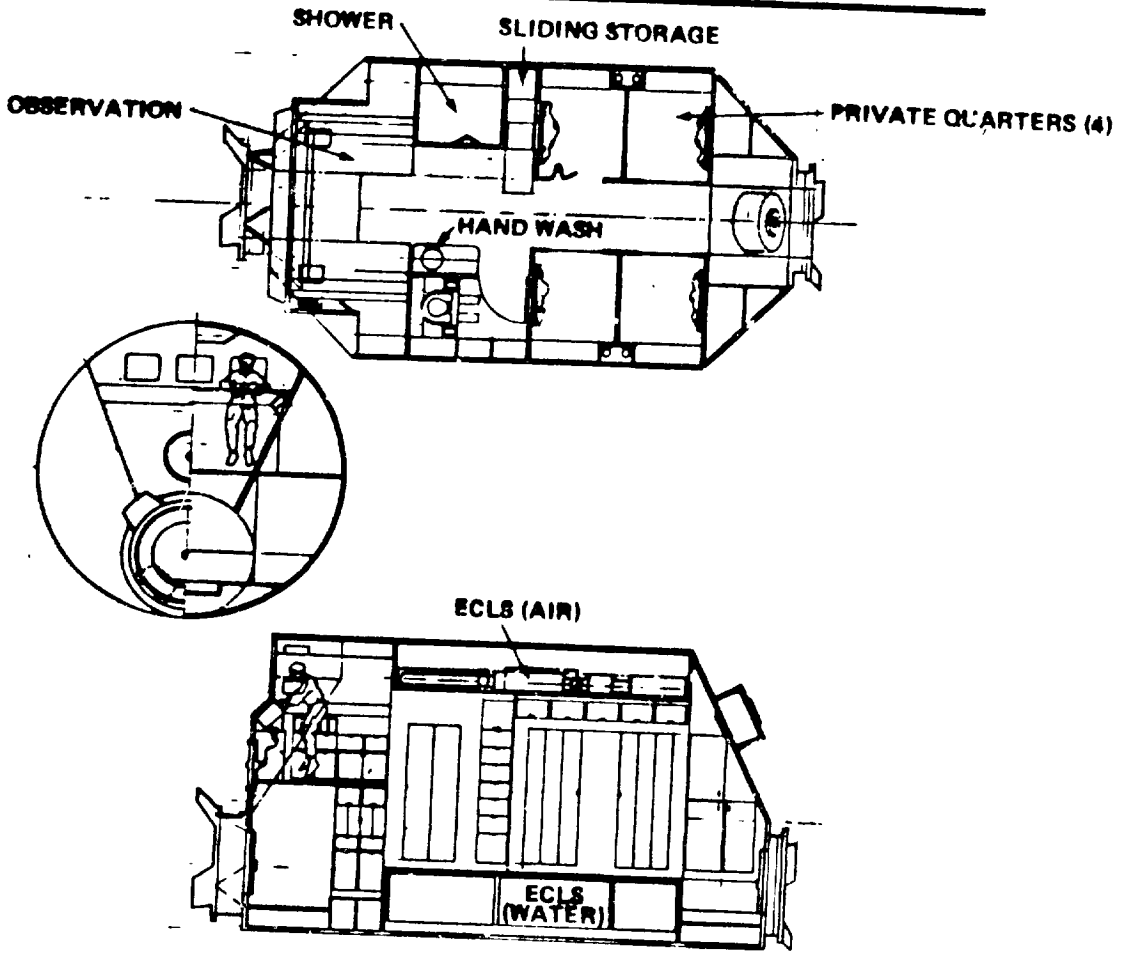
Crew Quarters Module



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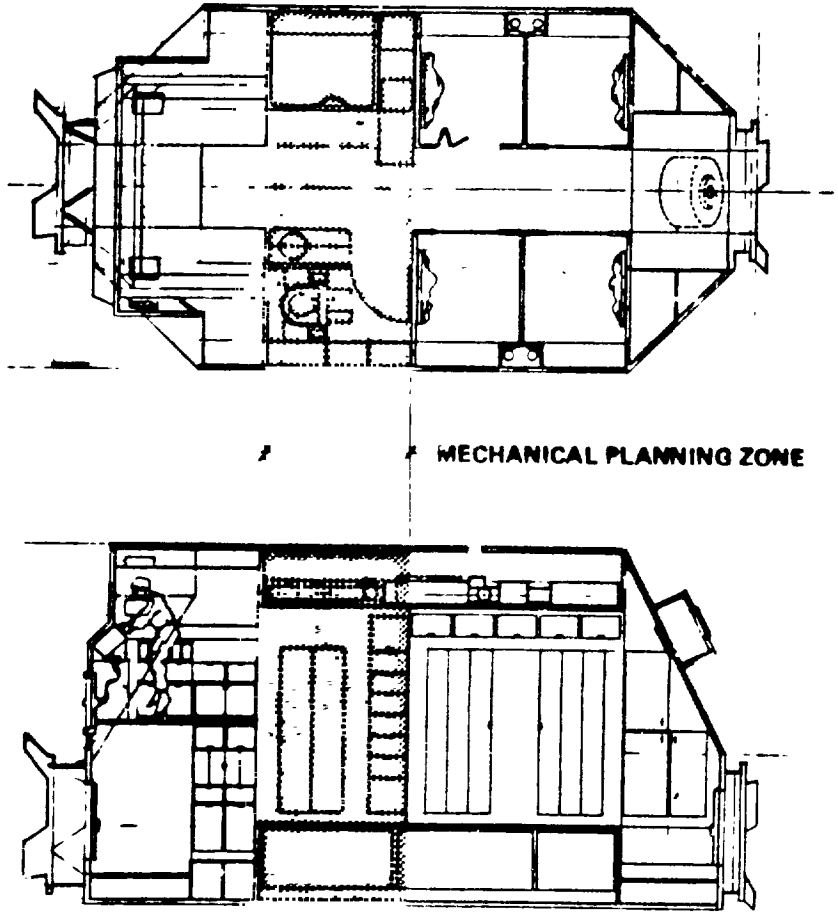
SOC-1434

Crew Quarters Mechanical Zone



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OPERATIONS
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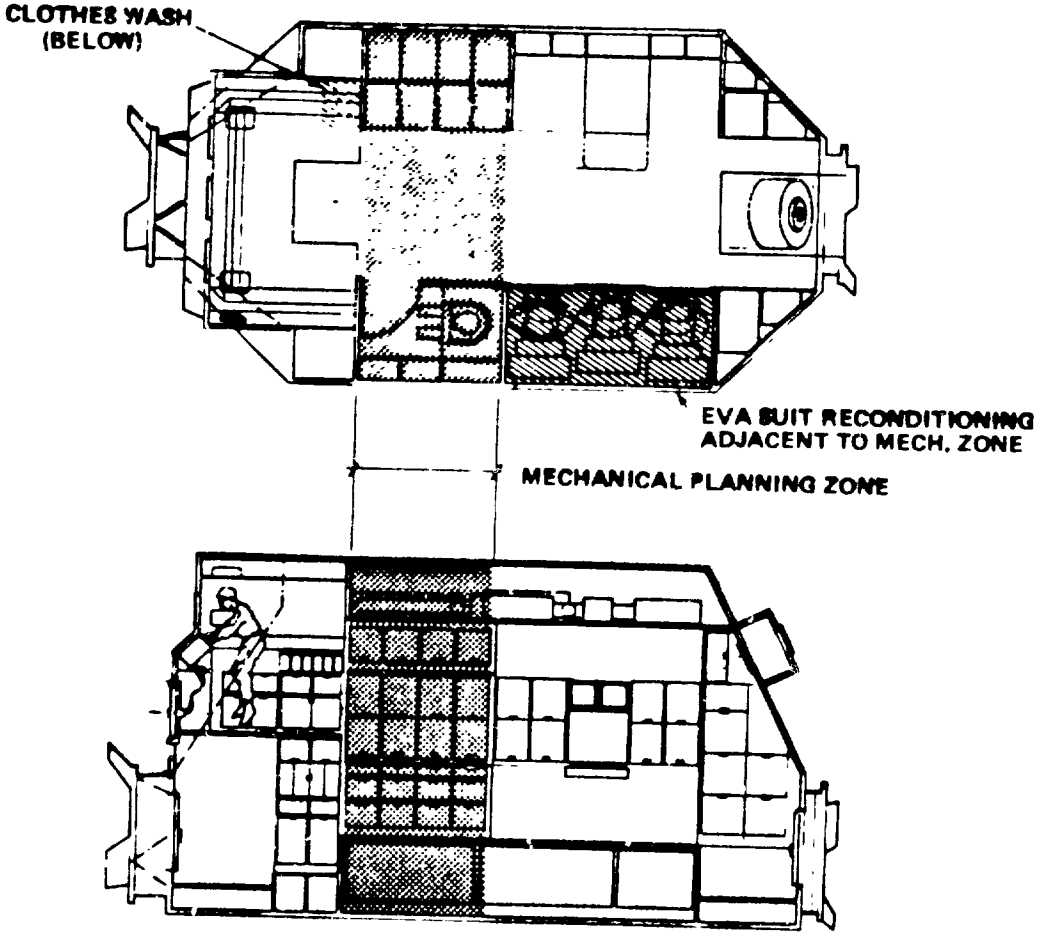
SOC 1429

Command/Control Mechanical Zone



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OPERATIONS
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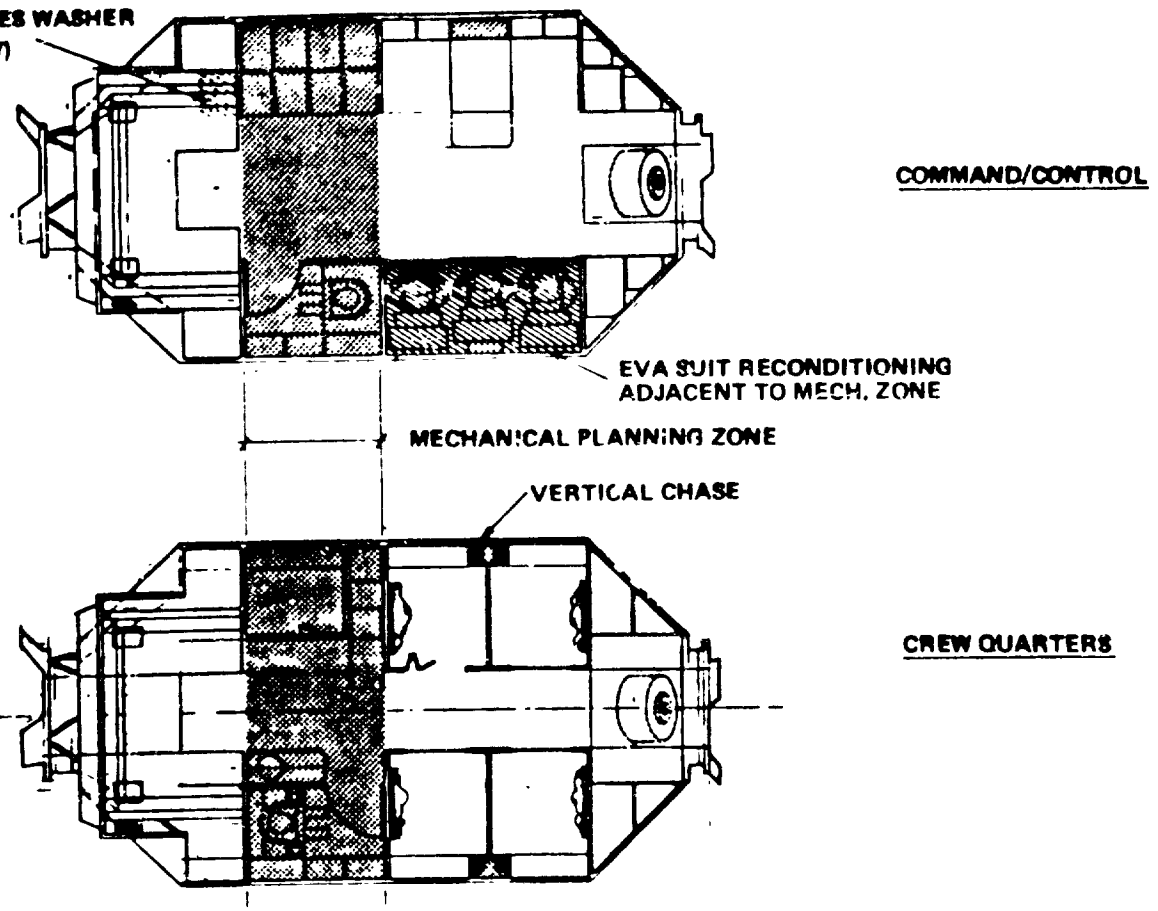
Comparative Mechanical Zone Placement

NASA
BOC 1433



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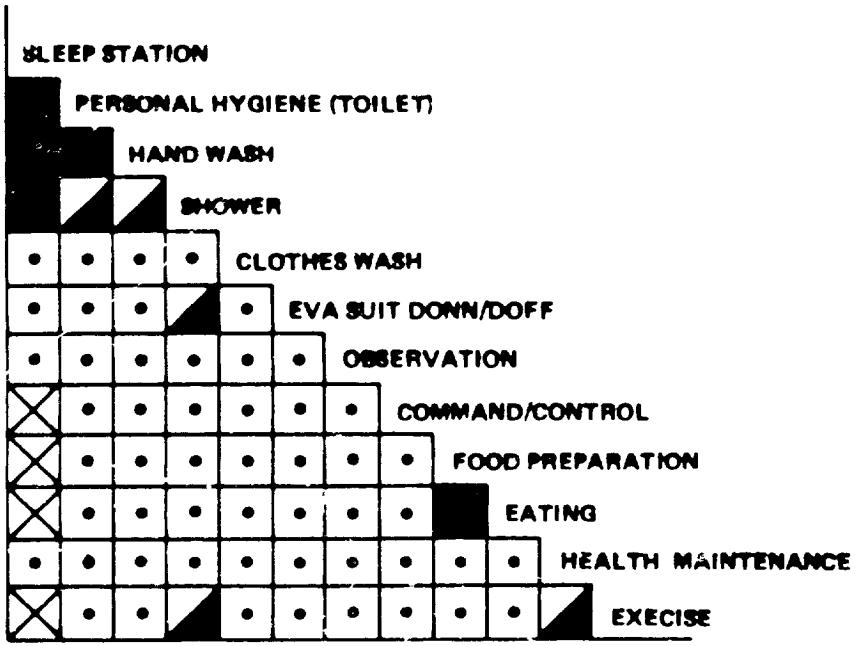
SOC 1488

Adjacency Matrix



CLOSE PROXIMITY

MODERATE PROXIMITY

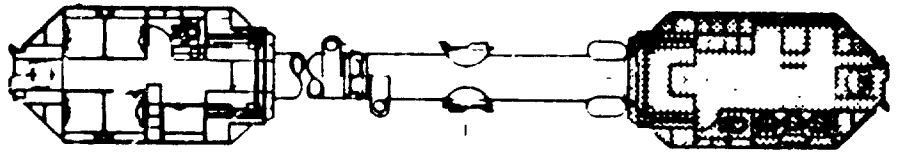
SEPARATION

NO PREFERENCE

SPACE
OPERATIONS
CENTER

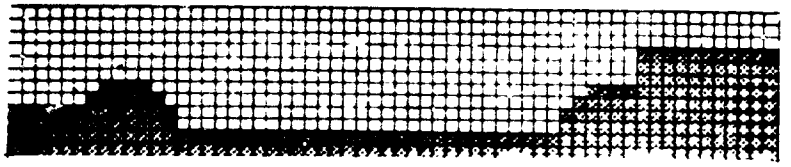
Open Space, Command/Control Module

NASA
SOC 1430



CREW QUARTERS

COMMAND/CONTROL



OPEN SPACE

COMMAND/CONTROL MODULE

SPACE
OPERATIONS
CENTER

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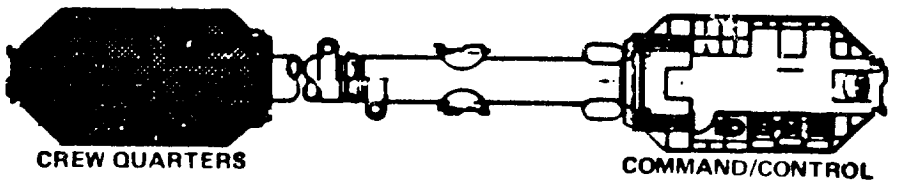
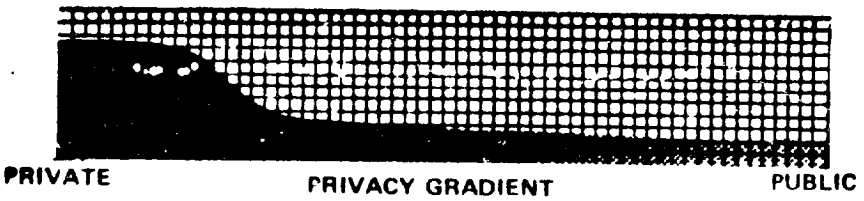
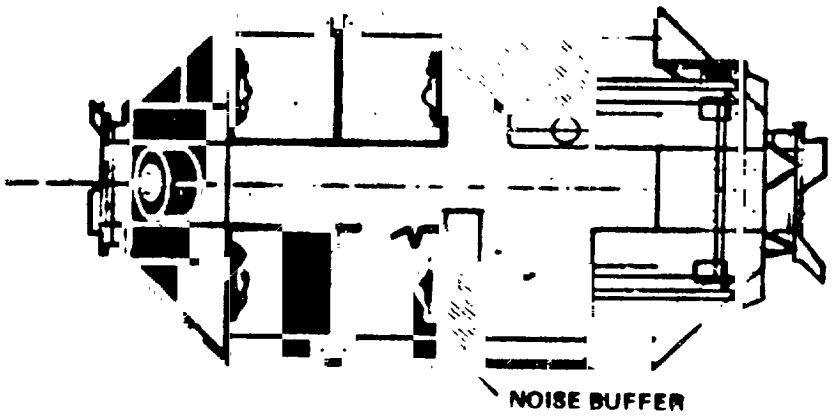
SOC-1436

Privacy Gradient







CREW QUARTERS MODULE

SPACE
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Redundancy

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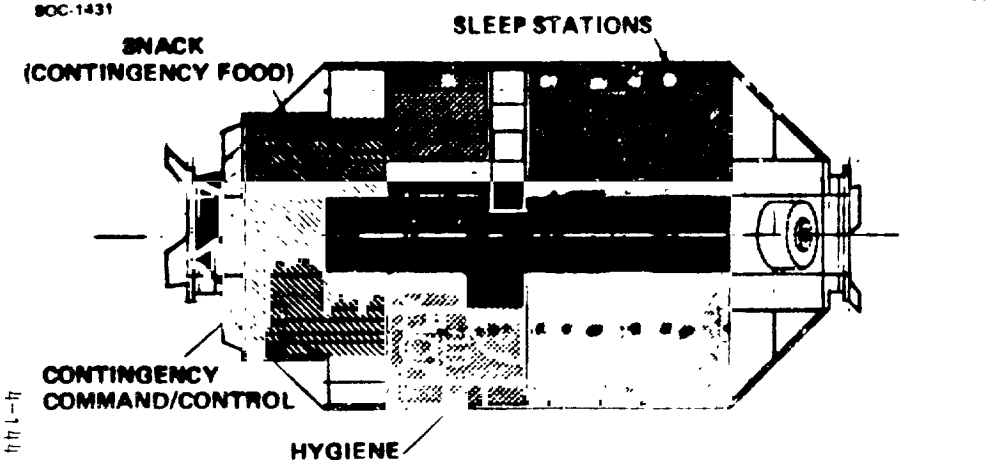
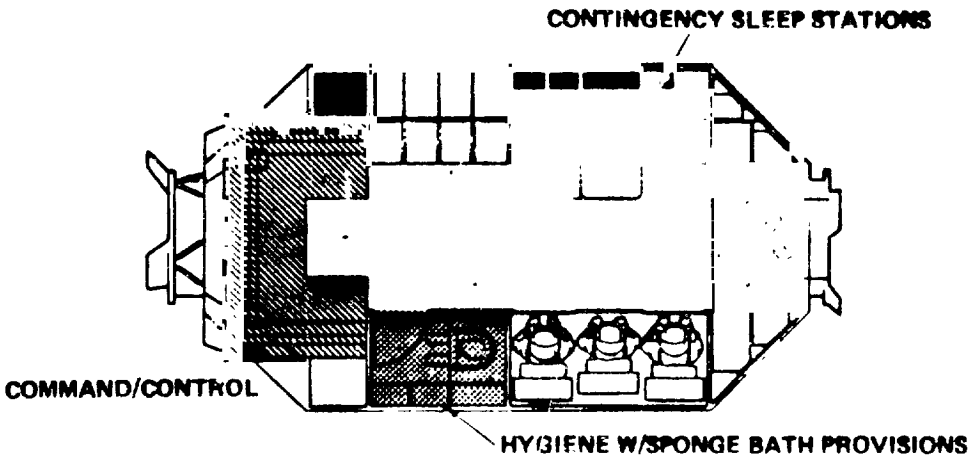


CREW QUARTERS



COMMAND/CONTROL

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Space Station

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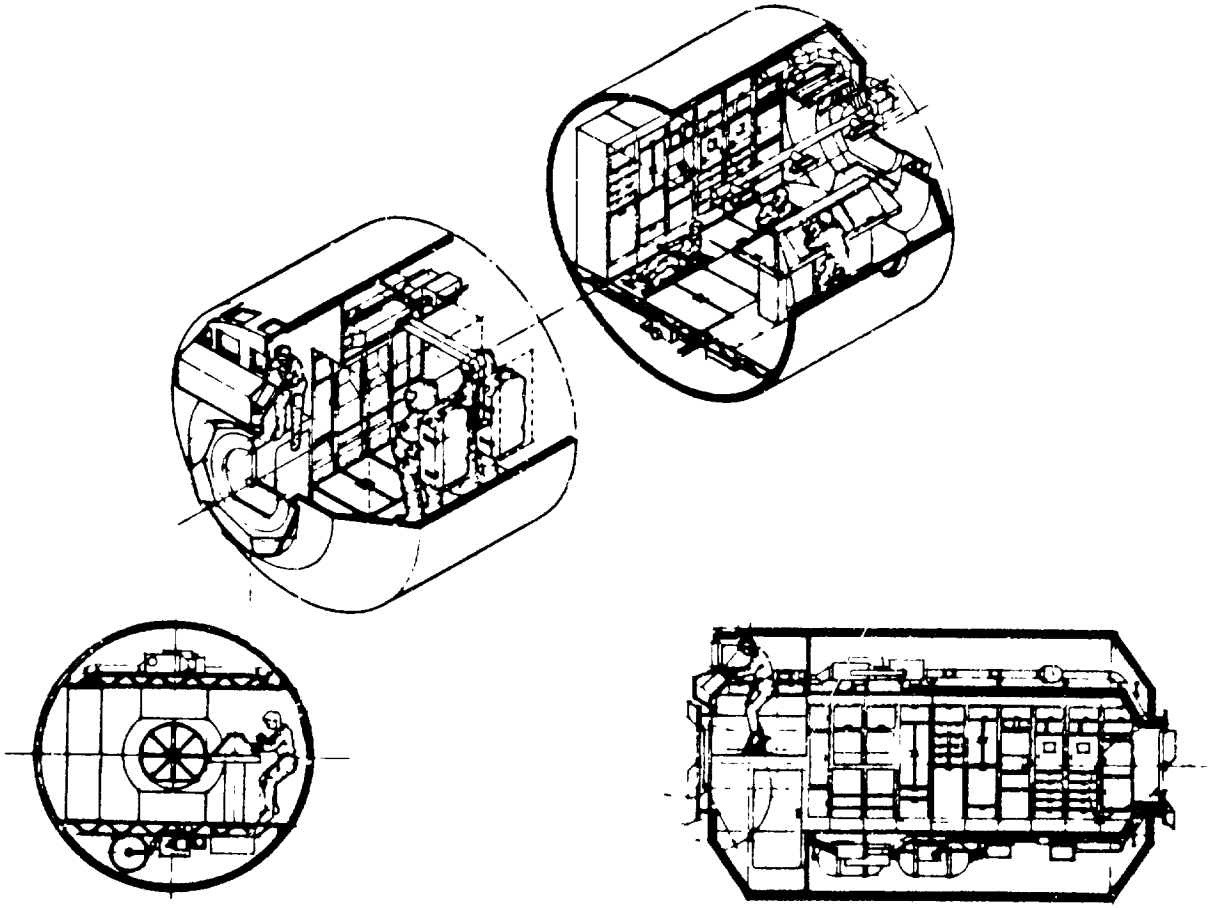
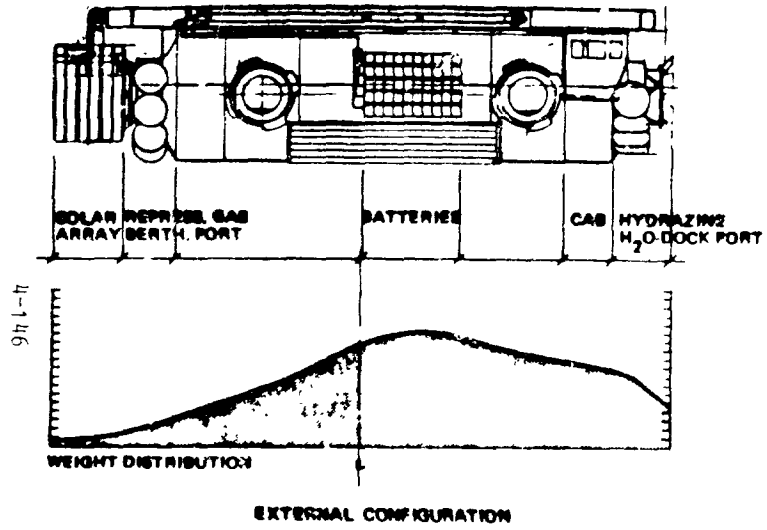
Space Station Common Module (Active)

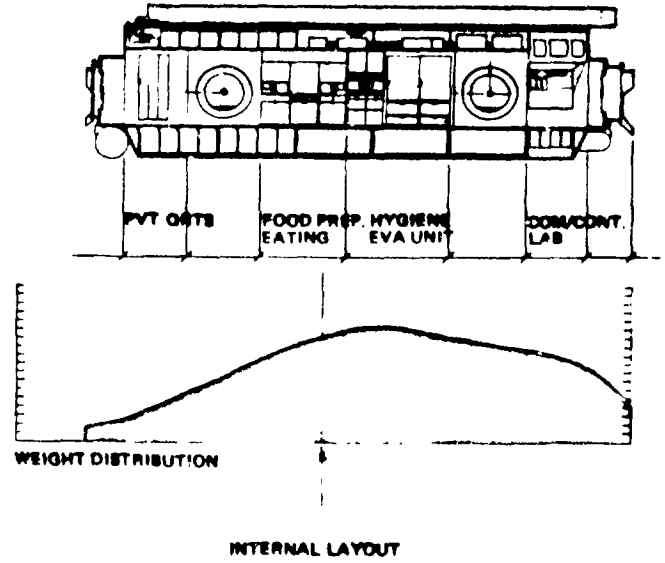


LARGE SPACE SYSTEMS

L38-034

Habitable Service Module Weight Distribution





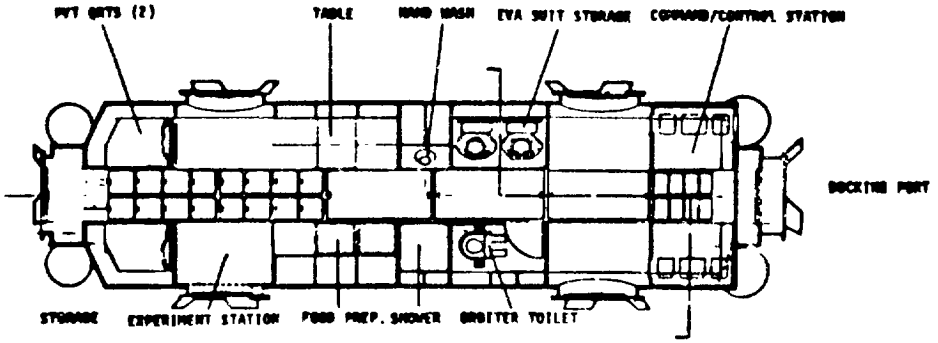
LARGE SPACE SYSTEMS

L88-033

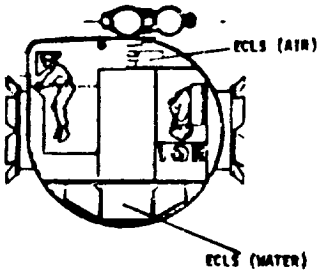
Habitable Service Module, Interior Layout

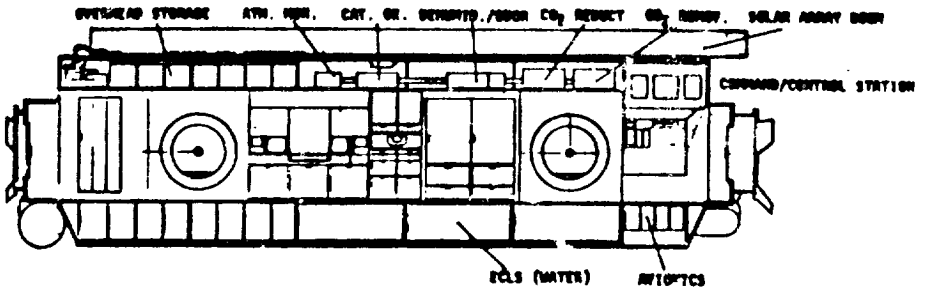
(2 Man Configuration)

SECTION VIEW



PLAN VIEW



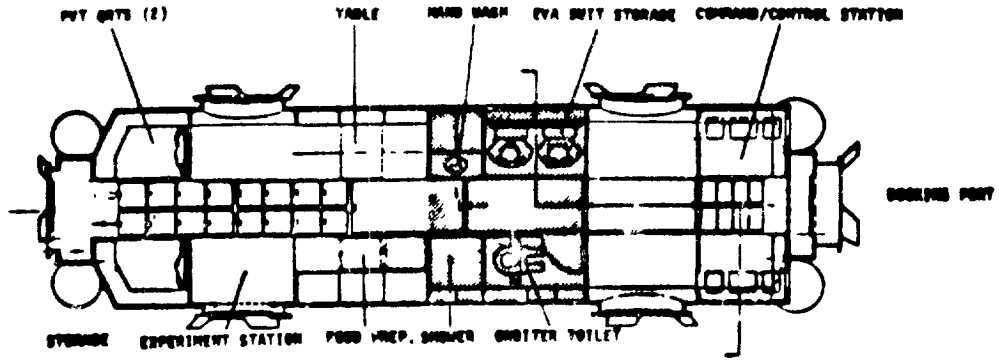


INBOARD PROFILE VIEW

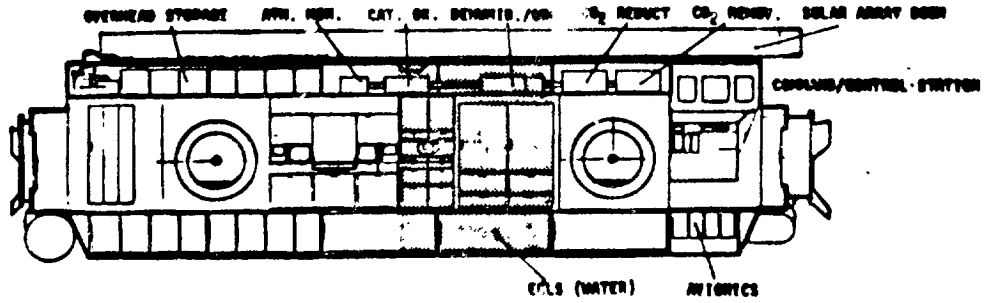
LARGE SPACE SYSTEMS

Hygiene/EVA Suit Storage Zone

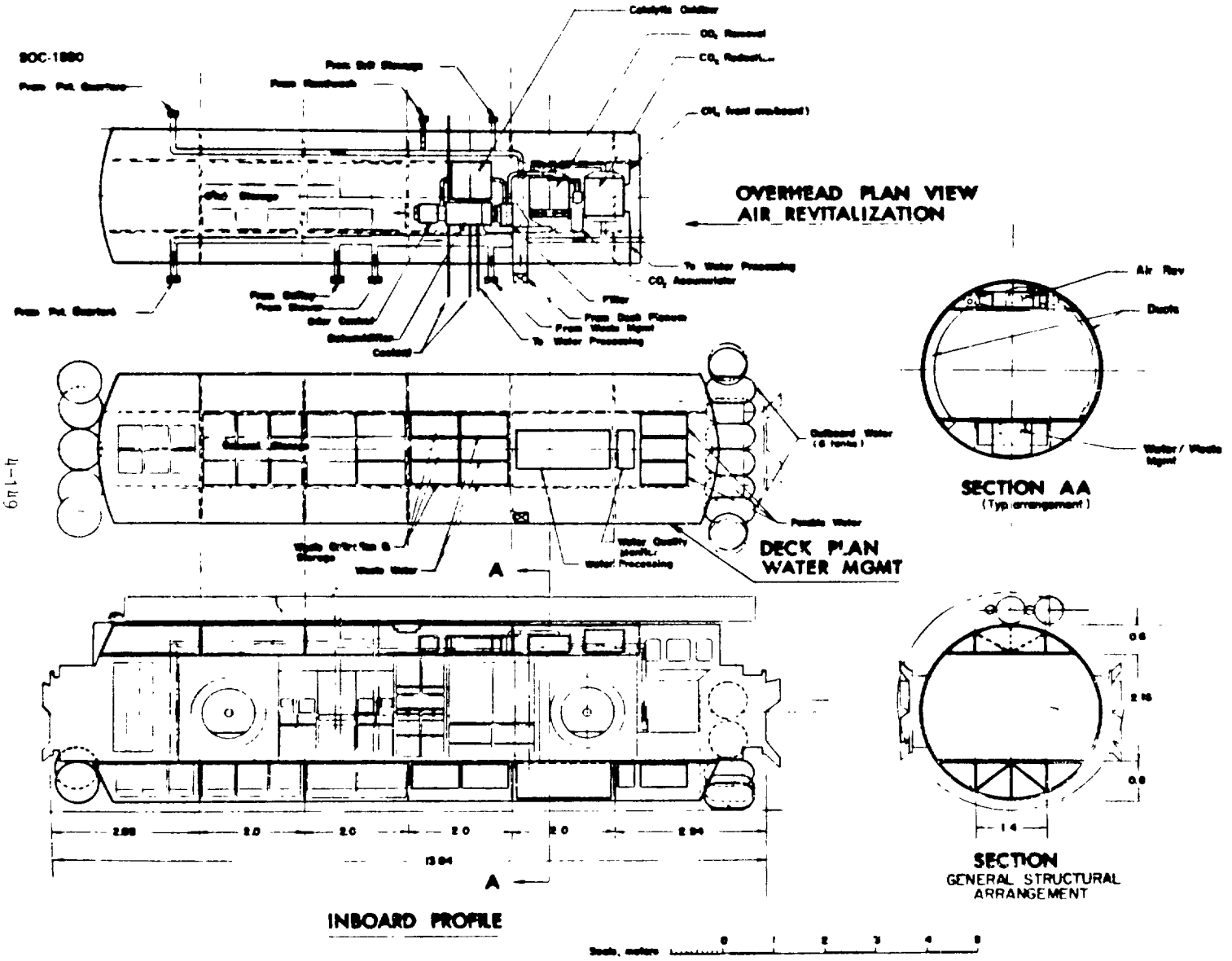
LSS-038



PLAN VIEW



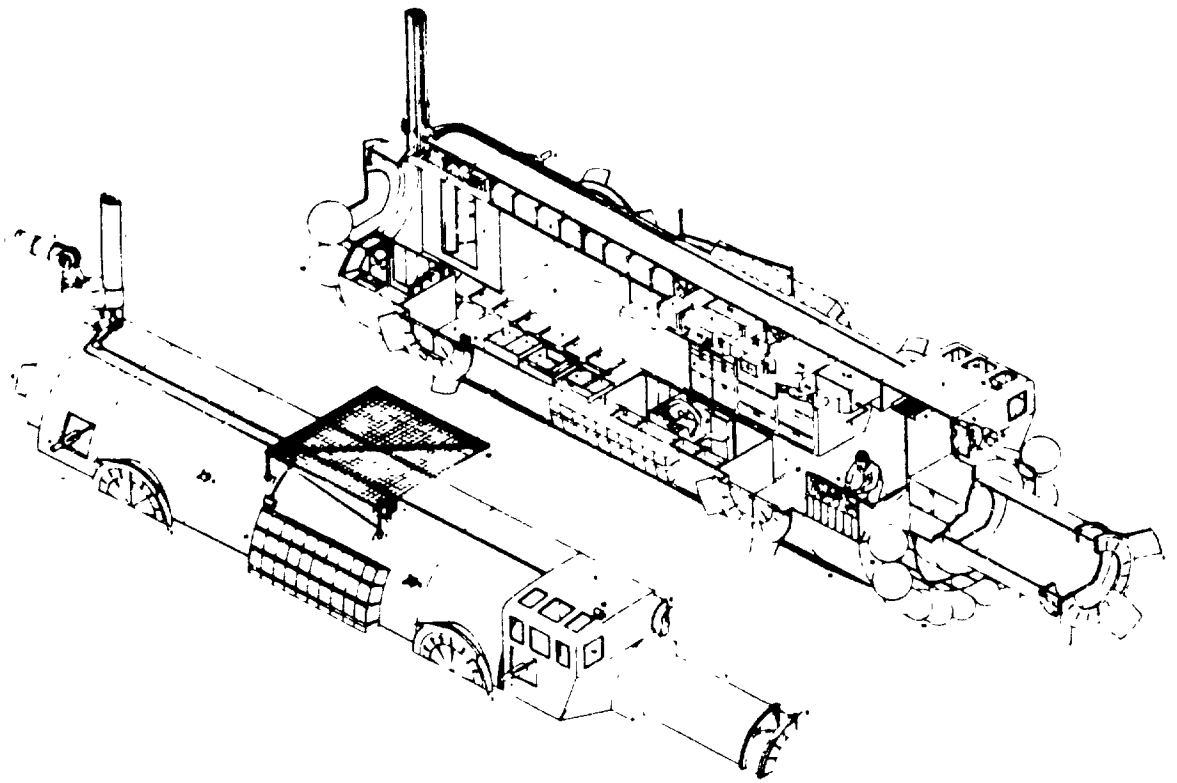
INBOARD PROFILE VIEW


SOC-1800
OVERHEAD PLAN VIEW
AIR REVITALIZATION
DECK PLAN
WATER MGMT
SECTION AA
(Typ arrangement)
A
A
INBOARD PROFILE
SECTION
GENERAL STRUCTURAL
ARRANGEMENT

Space Station

NASA

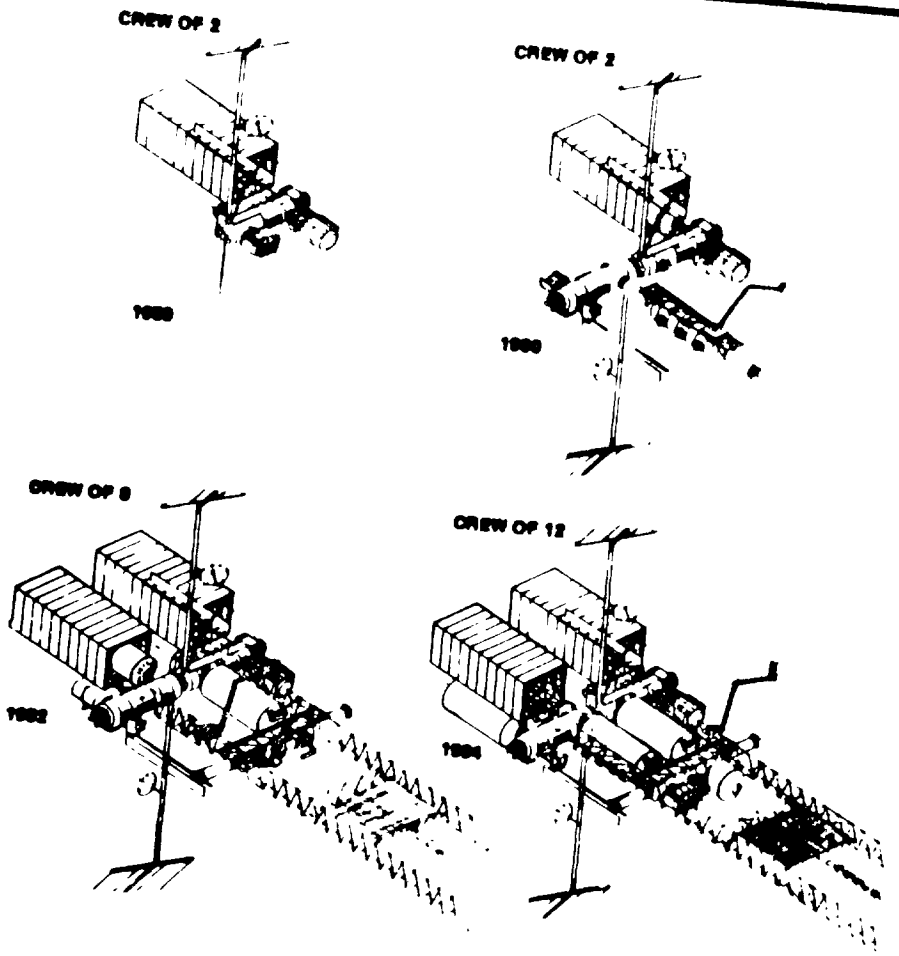
Hybrid Module/Interior-Exterior

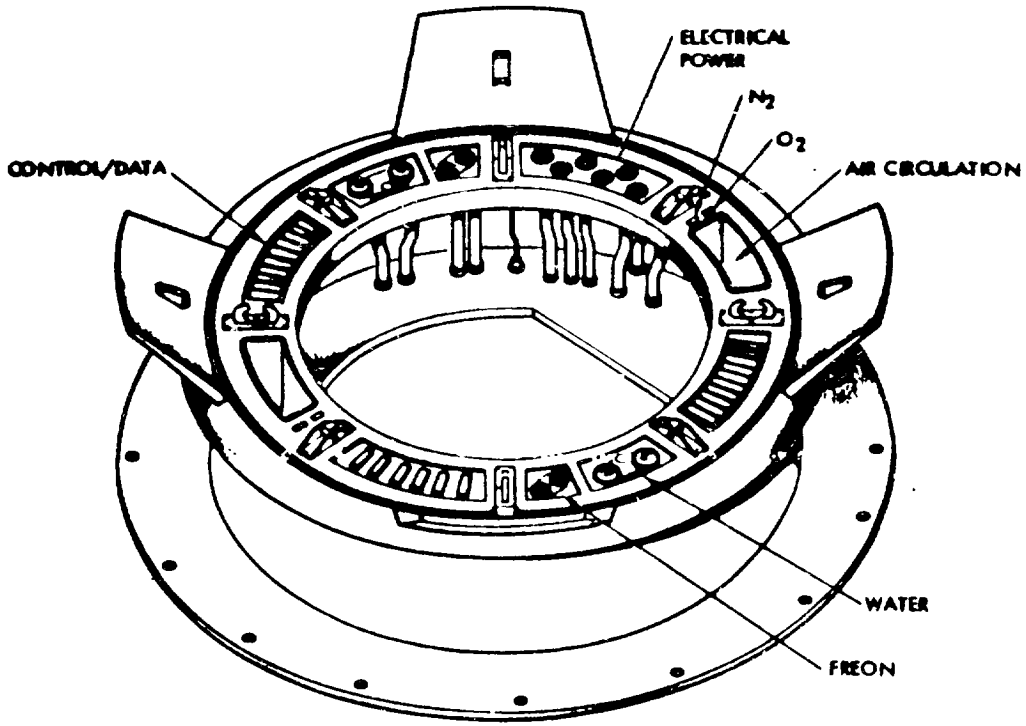


LARGE SPACE SYSTEMS

LMS-044

Mission Derived Build-up Sequence



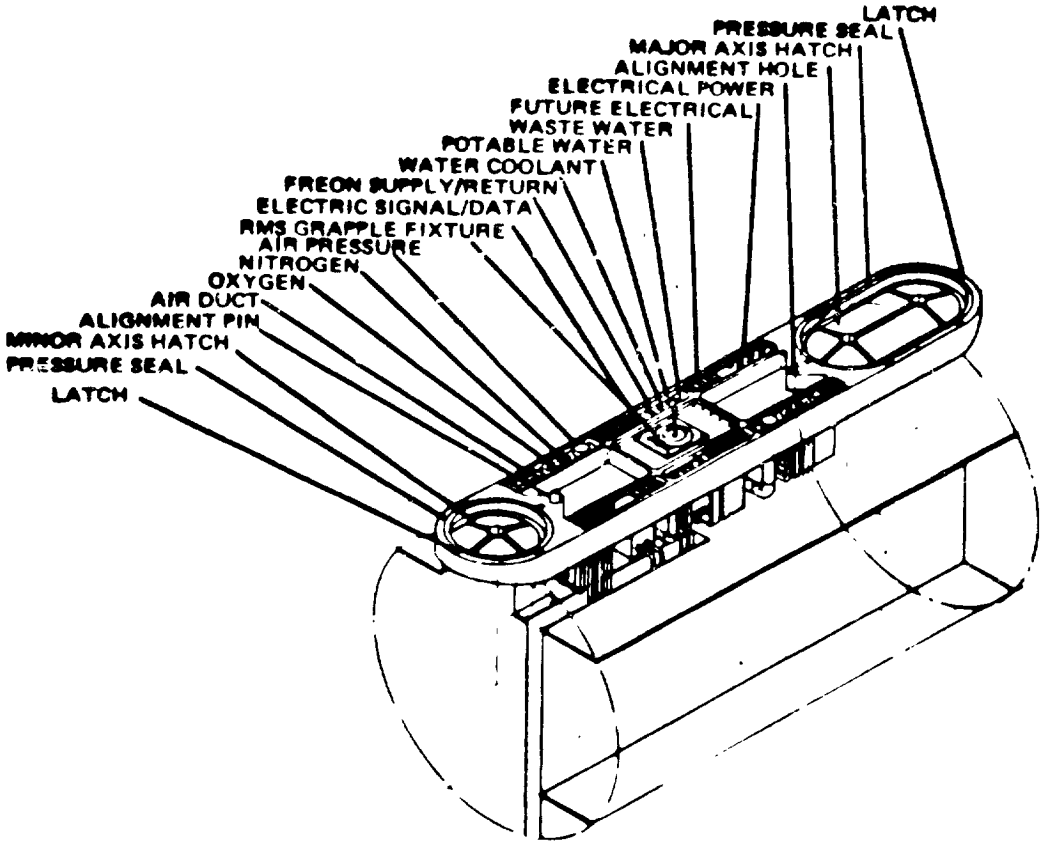


Space Station Module to Module Interface

Space Station

Berthing Interface Unified Architecture

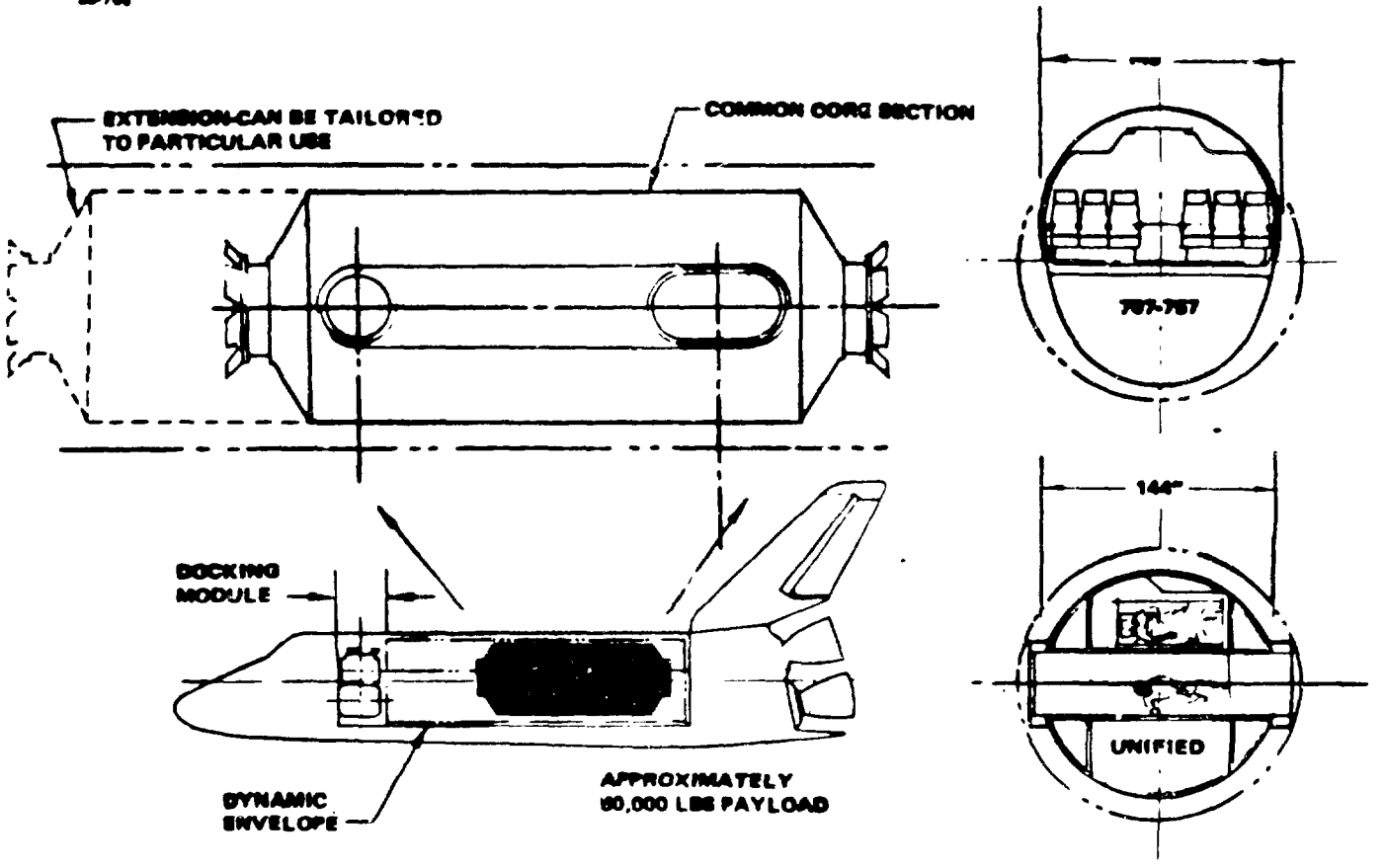
NASA



Space Station

Module Sizing Rationale
Unified Architecture

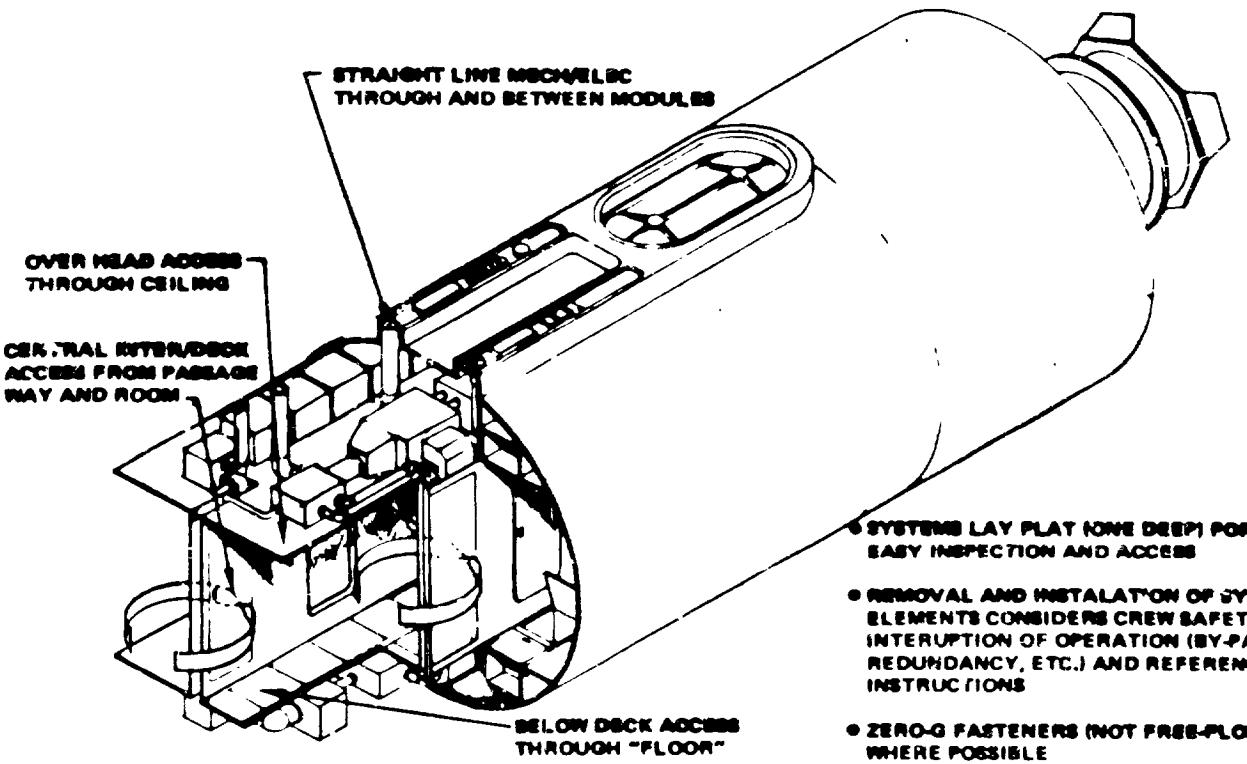
NASA



Space Station

NASA

On-Orbit Subsystem Accessibility

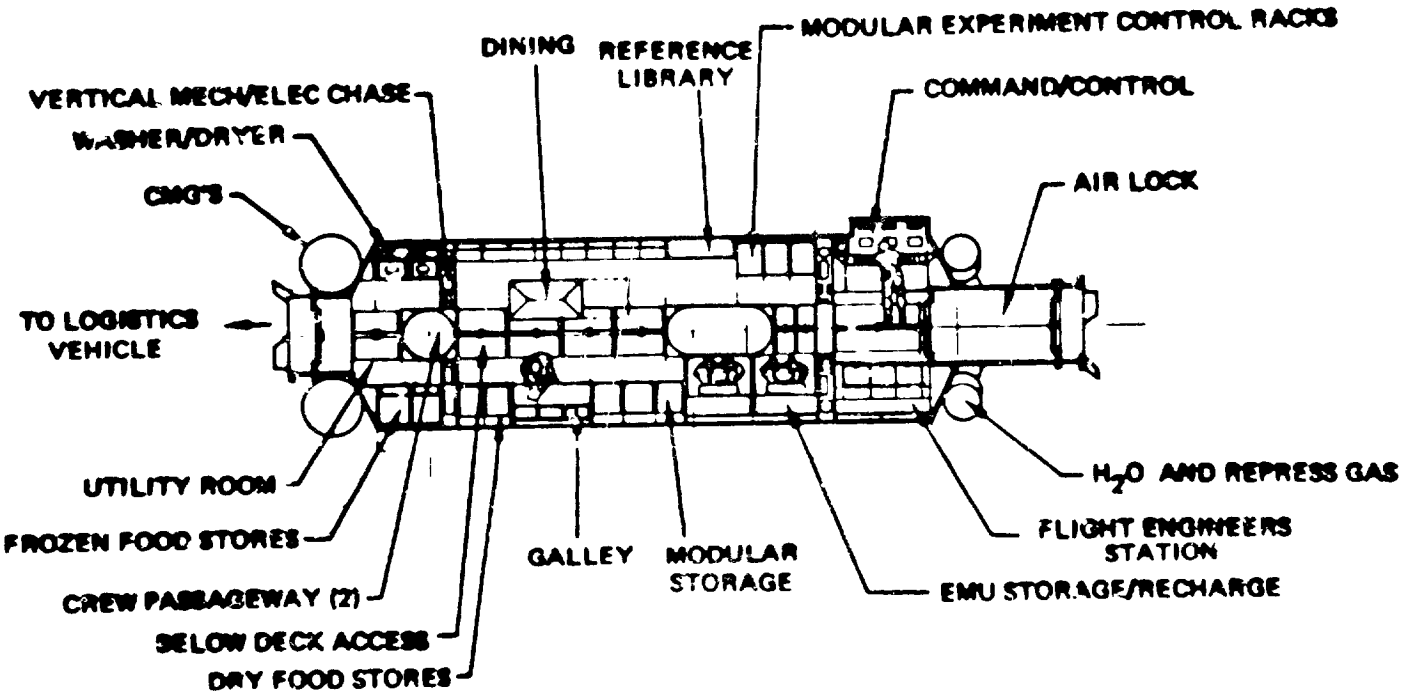


- SYSTEMS LAY FLAT (ONE DEEP) FOR EASY INSPECTION AND ACCESS
- REMOVAL AND INSTALATION OF SYSTEM ELEMENTS CONSIDERS CREW SAFETY, INTERUPTION OF OPERATION (BY-PASS, REDUNDANCY, ETC.) AND REFERENCE INSTRUCTIONS
- ZERO-G FASTENERS (NOT FREE-FLOATING) WHERE POSSIBLE

Space Station

Unified Module Shown in Command/Control Layout

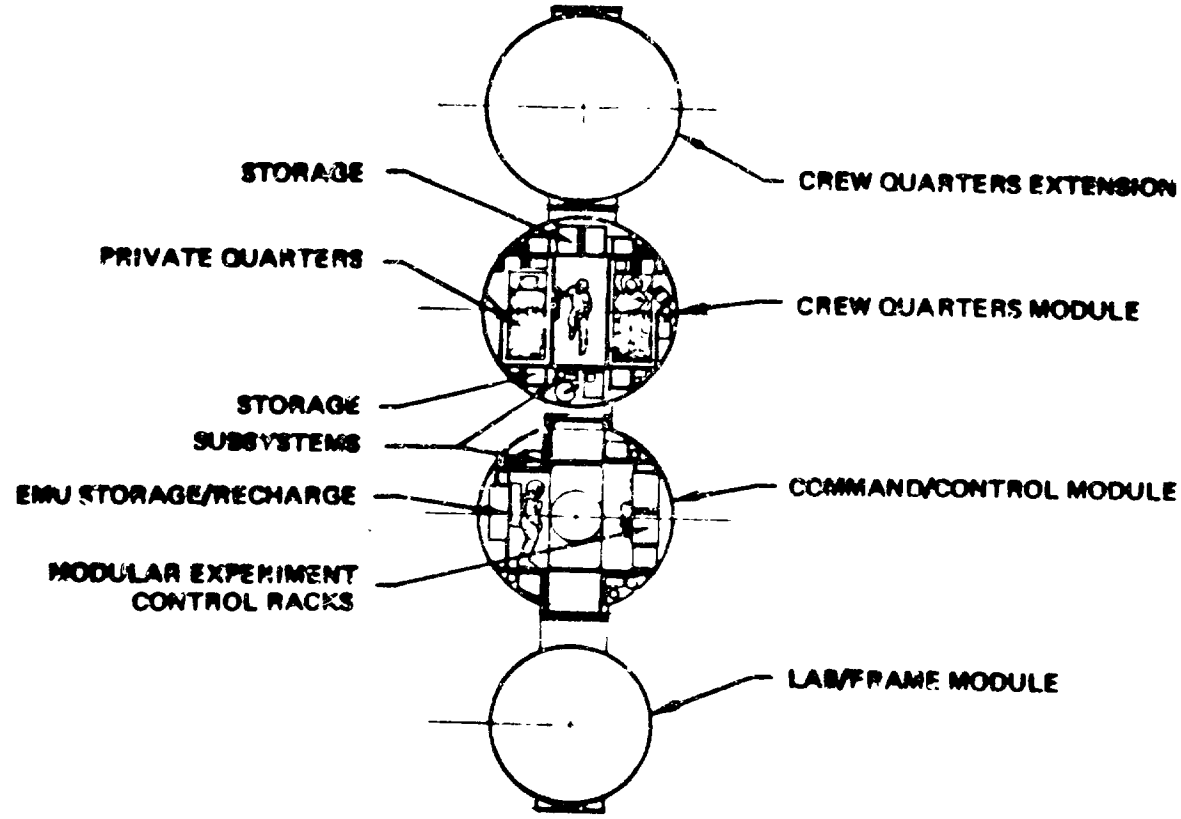
NASA



Space Station

NASA SS 711

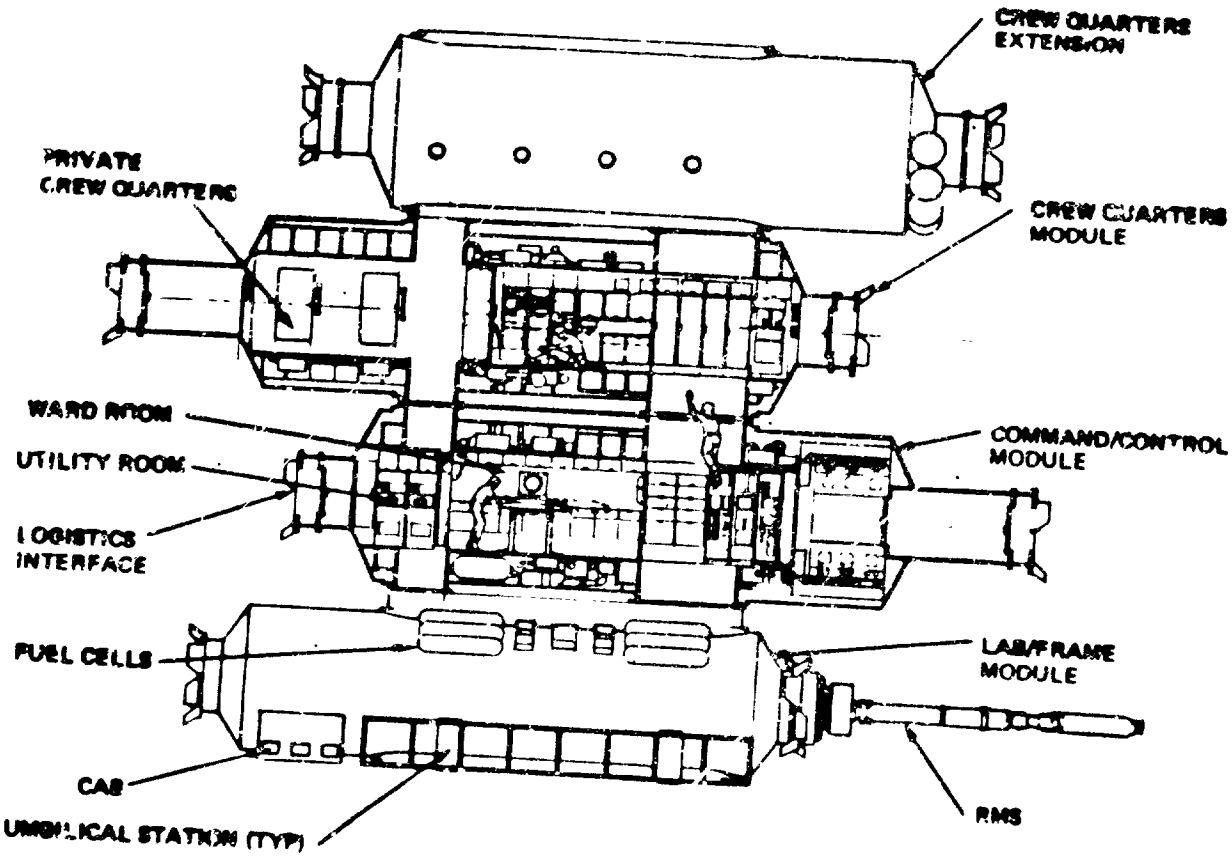
Transverse Section Unified Architecture



Space Station

NASA

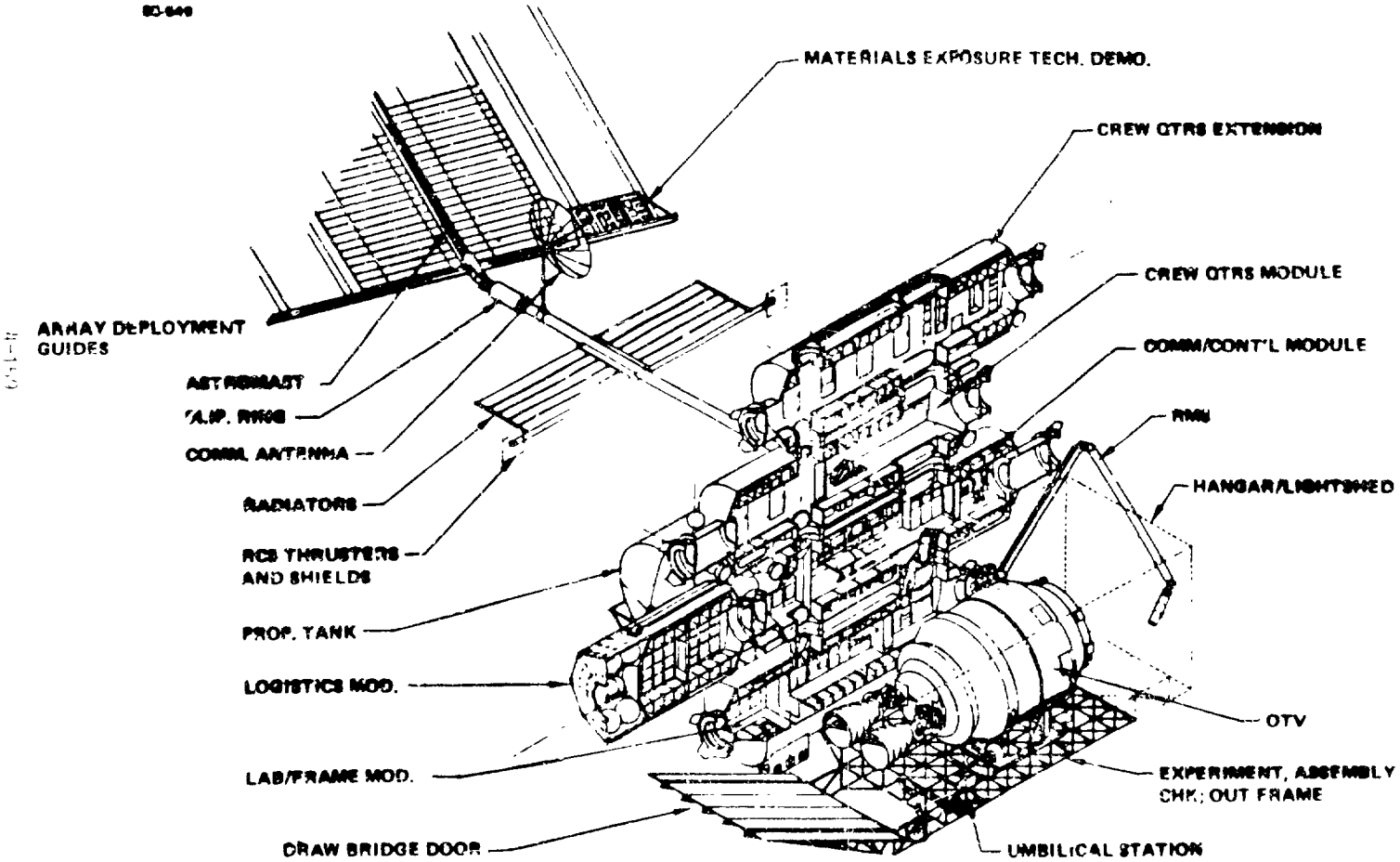
Section View of Crew Quarters and Command/Control Modules



Space Station

NASA

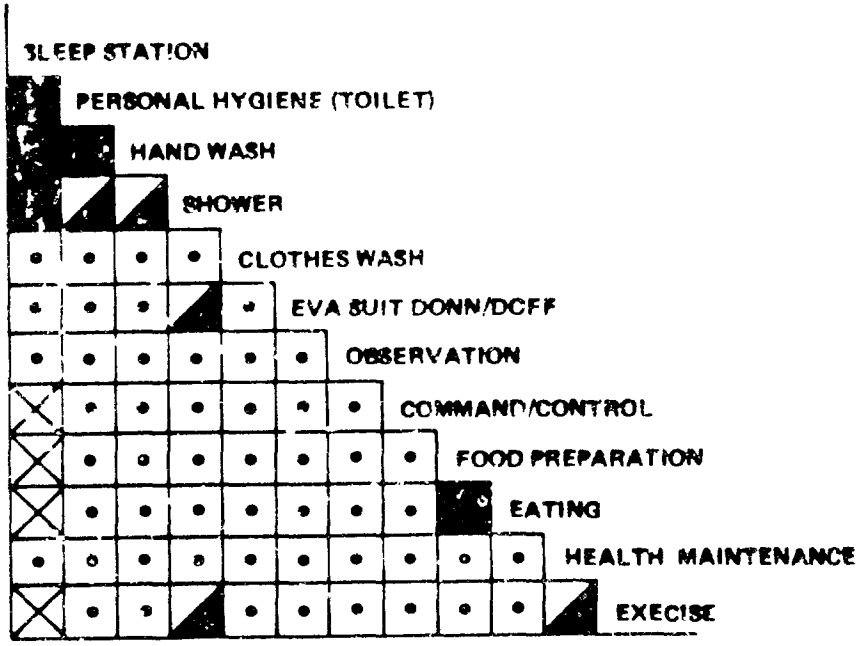
Cutaway View of Unified Space Station Architecture



SPACE
OPERATIONS
CENTER

NASA
SOC-1488

Adjacency Matrix



CLOSE PROXIMITY

MODERATE PROXIMITY

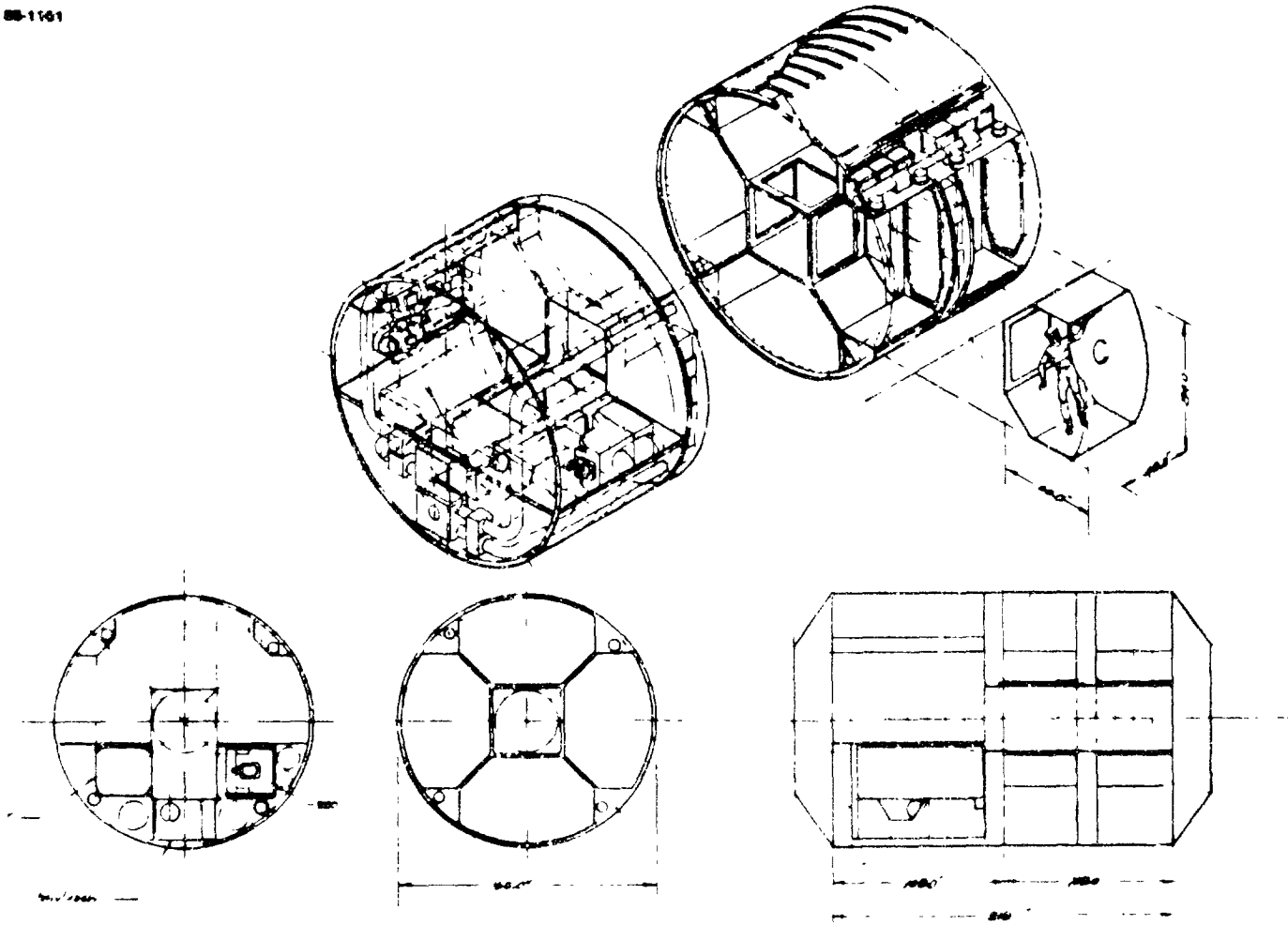
SEPARATION

NO PREFERENCE

Space Station

NASA

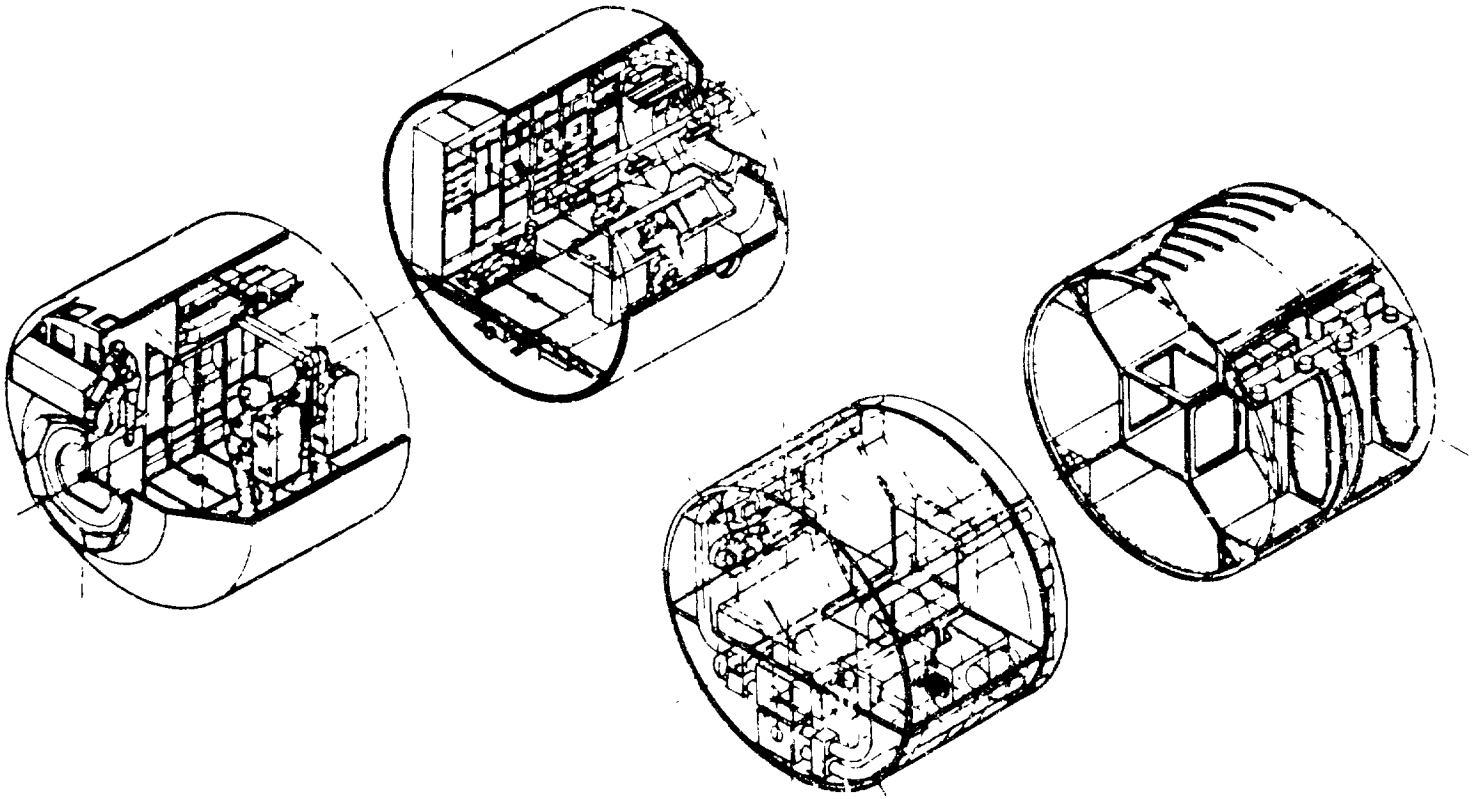
Space Station Common Module (Quiet)



Space Station

NASA

Space Station Common Module



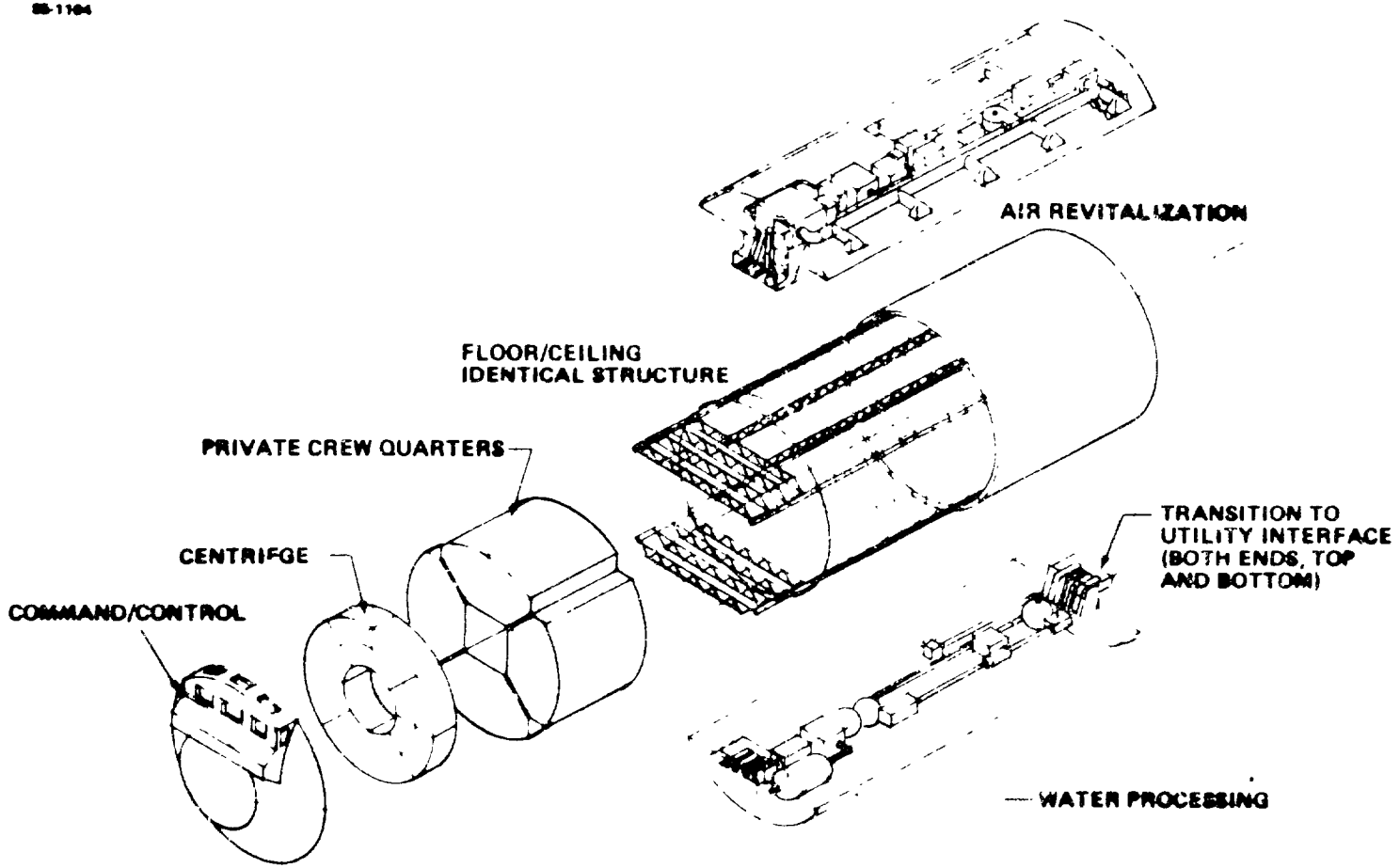
ACTIVE

QUIET

Space Station

NASA

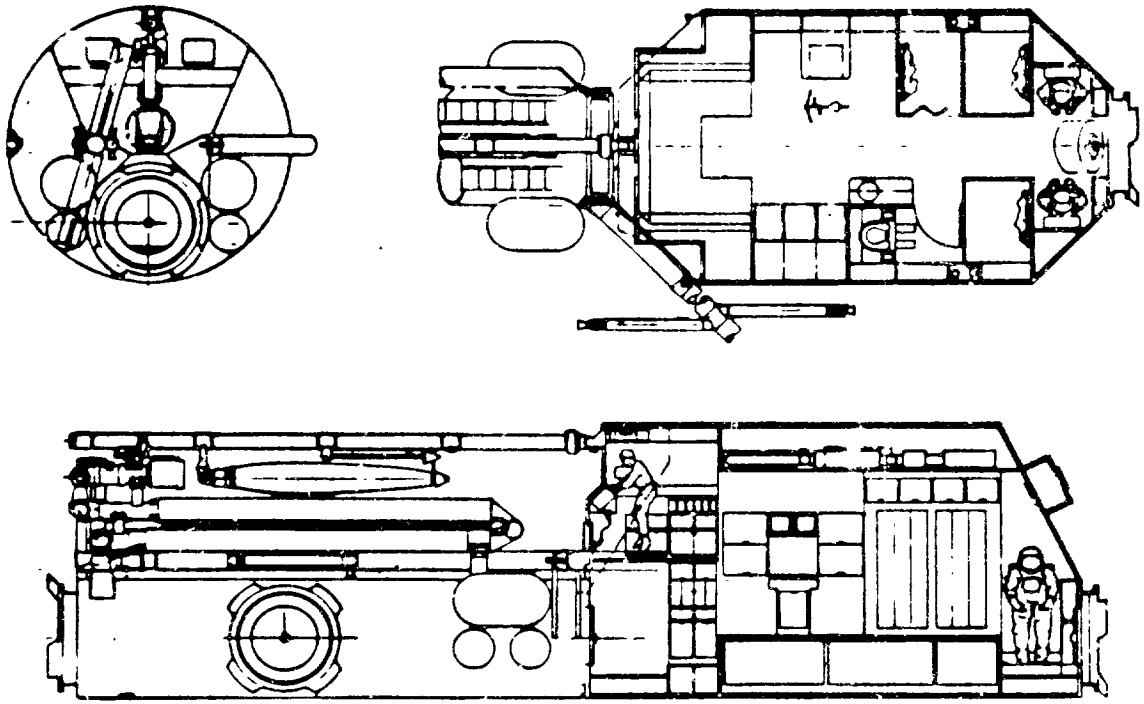
Common Module Elements



SPACE
OPERATIONS
CENTER

Interior, Single Launch Space Station

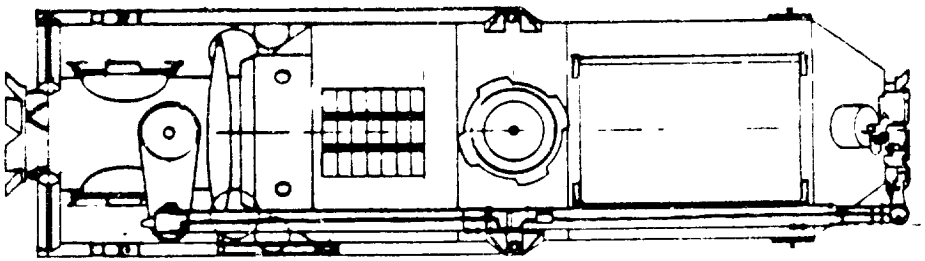
NASA
SOC-1424

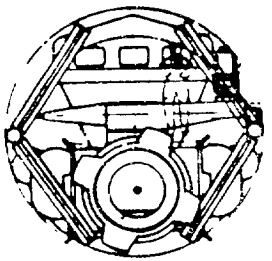


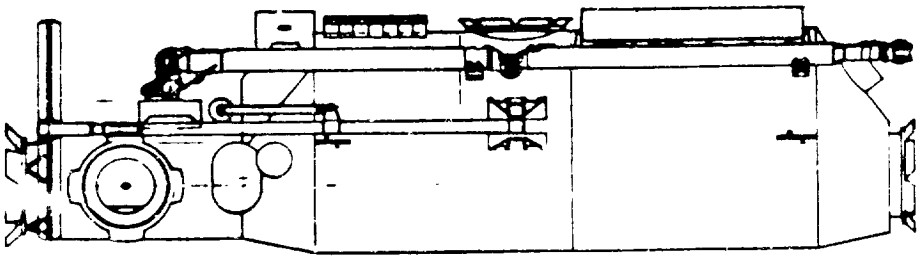
SPACE
OPERATIONS
CENTER

NASA
BOC 1478

Reduced Diameter Single Launch Space Station







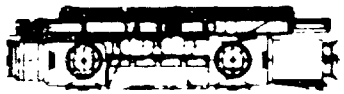
SPACE
OPERATIONS
CENTER

NASA
SOC-167

Habitable Service Module Evolution

DECREASING INITIAL COST

SOC REFERENCE SERVICE MODULE

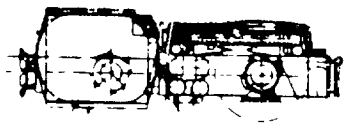


DESIGNED TO SUPPORT FUNCTION WITH A HABITABLE MODULE; NOT A "SAFE HAVEN"

EMERGENCY EQUIPMENT ADDED

CREW PROVISIONS ADDED TO PERMIT EMERGENCY SURVIVAL

FIRST ATTEMPT REPACKAGING



TWO-DIAMETER DESIGN ACCOMMODATES TWO PEOPLE BUT DEPLOYMENT IS COMPLEX

SECOND REPACKAGING

3.5-METER DIAMETER ACCOMMODATES THREE PEOPLE WITH SIMPLIFIED DEPLOYMENT

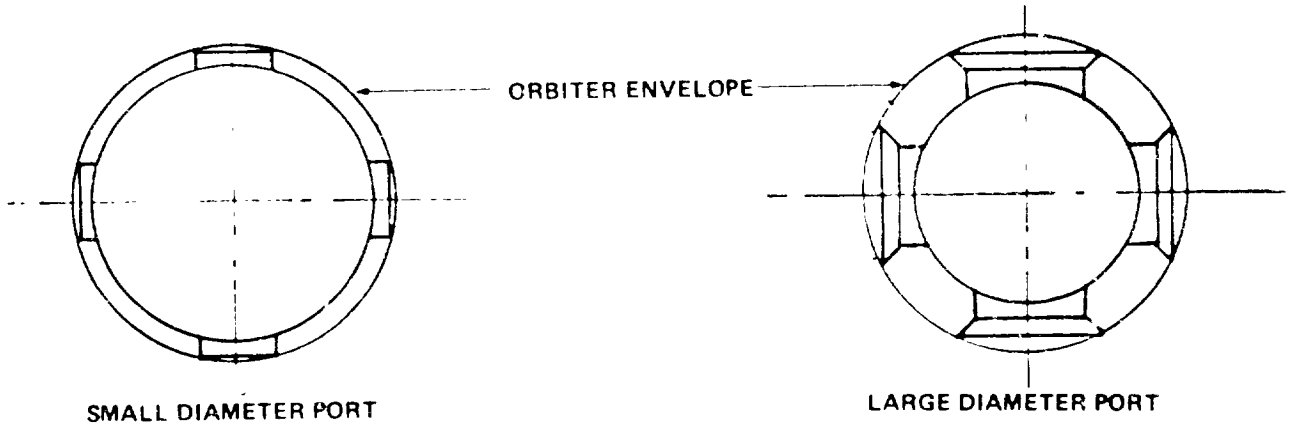
Space Station

NASA

SS-1118

Docking and Berthing Ports

ASSUMING A "GIVEN" DESIGN FOR A DOCKING PORT:



SMALL PORT PERMITS LARGER DIAMETER MODULE BUT MAY MAKE DOCKING/BERTHING MORE DIFFICULT.

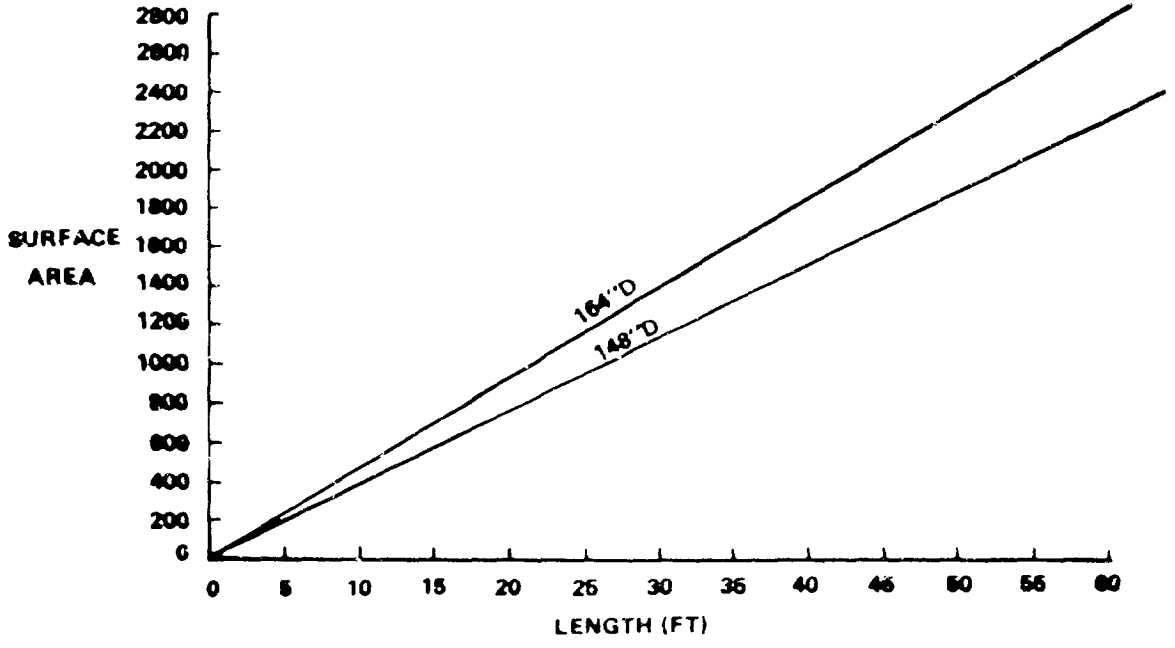
LARGE PORT PERMITS EASIER DOCKING/BERTHING BUT REDUCES DIAMETER OF MODULE.

PORT DESIGN NEEDS TO BE ESTABLISHED EARLY IN PROGRAM

Space Station

NASA

Surface Area Comparison for Two Space Station Modules

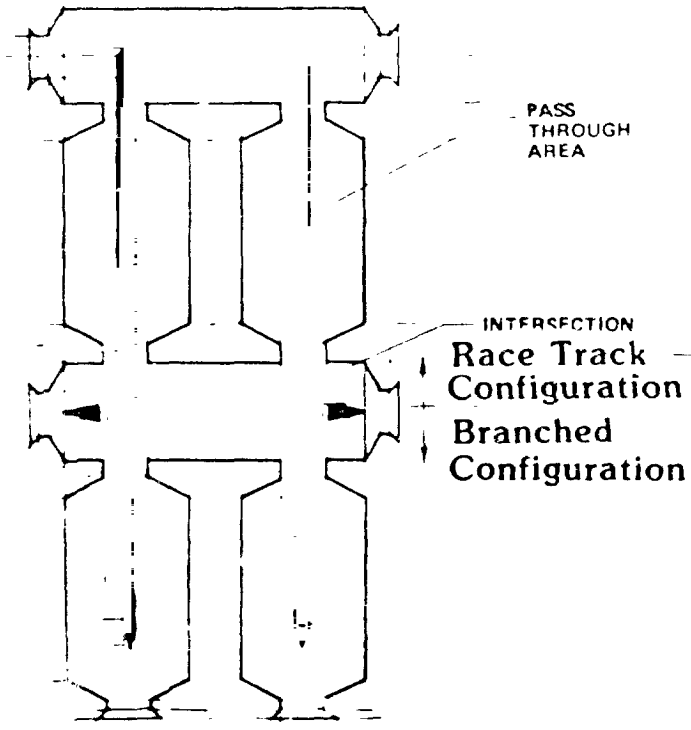


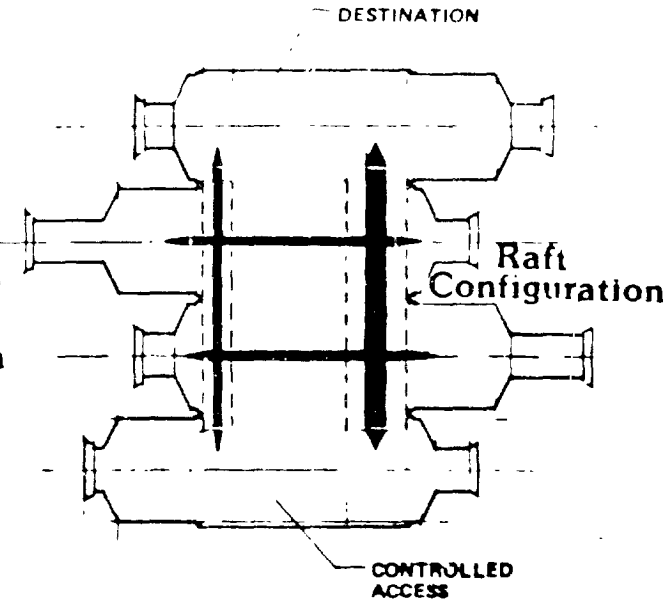
Space Station

NASA

SS-1120

IVA Circulation





AXIAL CIRCULATION

- RACE TRACK–ALL AREAS ARE PASS THROUGH
- BRANCHED–CAN ARRANGE PRIVACY ALONG AXIS AWAY FROM CORE

TRANSVERSE CIRCULATION

- MINIMUM INTERRUPTION TO ACTIVITIES IN MODULE
- BETTER PRIVACY GRADIENT (CONTROLLED ACCESS)

Space Station

NASA

SS-1119

Volumetric Efficiency